AMERICAN COLLEGE OF EMERGENCY PHYSICIANS
SCIENTIFIC ASSEMBLY
1999

Ultrasound for Beginners: The Machine, Technology, and Technique

Bedside ultrasound is now part of the scope of practice and knowledge of the emergency physician, yet many physicians have not had much exposure or formal training in bedside ultrasound. This session will provide an introduction to the technique. Emphasis will be placed on knobology, physics, probe characteristics and selection, and probe placement for the traditional examinations of the pericardium, aorta, and right upper quadrant; the pelvis; and the trauma patient.

- Describe how to use the basic ultrasound machine, including the viewing screen and the functions of the major controls.
- Explain the physics of ultrasound and the indications for each probe type.
- Demonstrate the probe placement for examination of the aorta and right upper quadrant, the pericardium, the pelvis, and the trauma patient.

TU-62
Tuesday, October 12, 1999
8:00 AM - 8:55 AM
Room # N212
Las Vegas Convention Center

FACULTY

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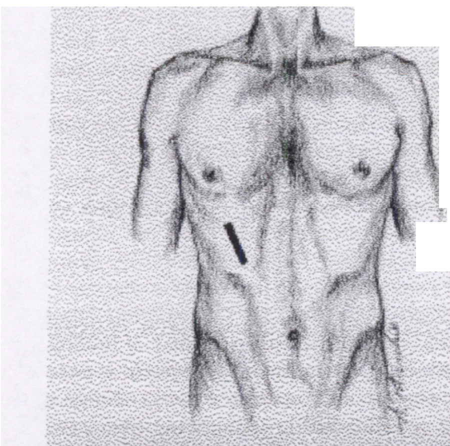
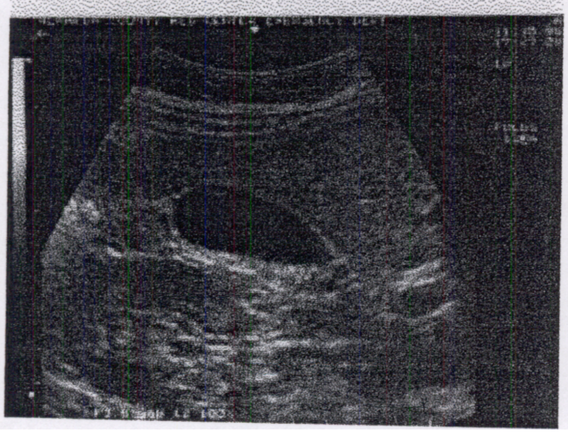
RUQ Scanning Technique

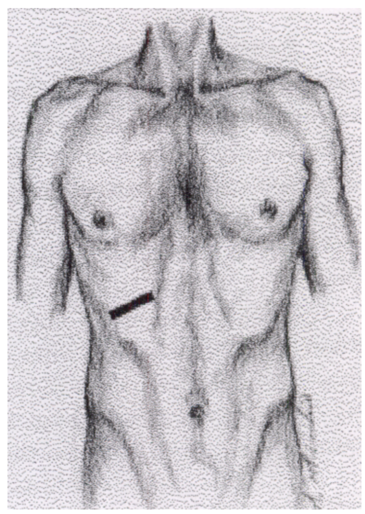
The scanning protocol for the RUQ is initially a straight forward exam but with increasing experience, the complexity of the exam becomes apparent. For limited, goal directed exams the protocol is not too complex.

I. Gallbladder

The galbladder can rest in many different locations within its fossa. Generally it is best to start with a right of midline longitudinal approach. Have the patient hold a deep breath. This usually brings the gallbladder down below the costal margin. It should also be interogated in the transverse position. If you are unable to visualize the GB then attempt to use a coronal approach similar to the RUQ view in the trauma exam. Generally you will be about one ICS higher when looking for the GB. This approach is very effective in the obese patient. Fan the transducer back and forth to visualize the entire GB.

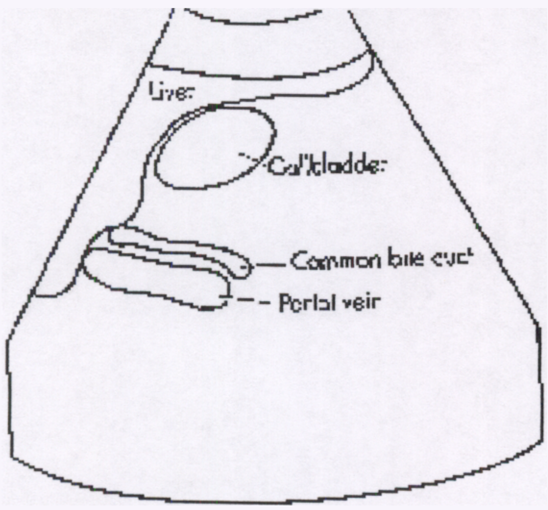


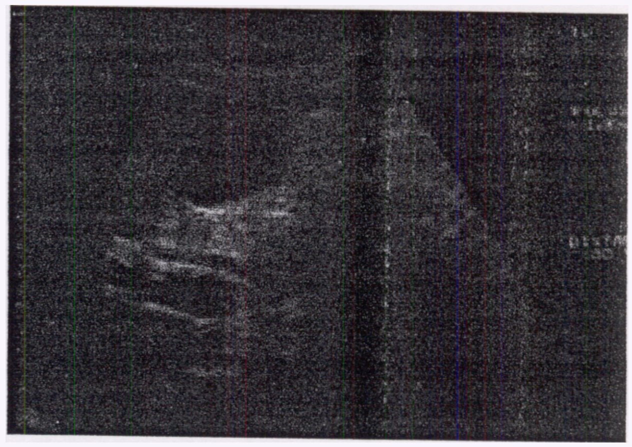




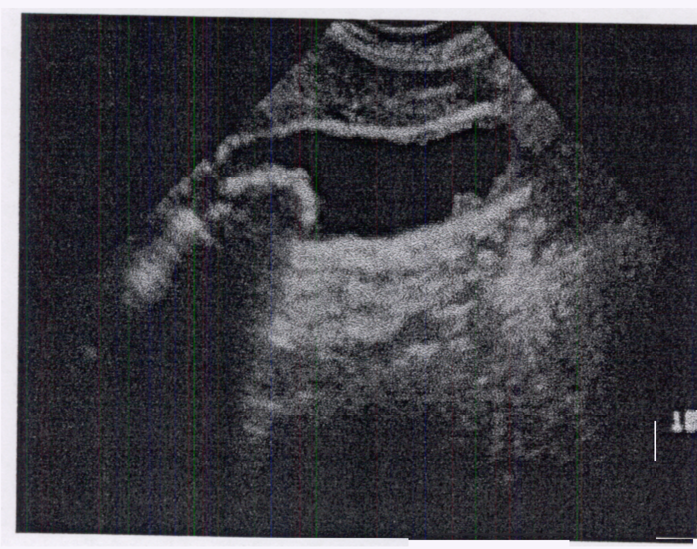
II. Common Bile duct

The CBD is a more difficult structure to visualize. It runs with the portal vein and hepatic artery. By locating the portal vein you will locate the CBD. It sits immediately in the near field to the portal vein. Frequently you will only see portions of the structure. It should be less than 5mm in diameter. The hepatic artery can occasionally be mistaken for the CBD. This can make the exam more difficult. Placing the transducer trans and midline is a good place to start in locating the CBD





III. Stones



Gallstones can range in size and number and vary in their ability to be detected. Stones over 5mm generally cause shadowing and are easier to see. Stones smaller may not shadow and can be difficult to see. Rolling the patient can move stones and make it easier. Be careful not to overcall edge artifact or stool in the bowel which can shadow at times. To measure a thick GB wall the near field should be measured. It should be less than 5mm. The far field wall will be obscured by enhancement artifact.

Ultrasound in Abdominal Trauma

John S. Rose, M.D.

Introduction

1. Perspective
2. Application
3. Pitfalls
4. Case studies

Perspective

A. Blunt Abdominal Trauma

1. accounts for 20-30% of operative interventions in trauma (Mattox 1991)
2. difficult diagnostic entity
3. 43% of significant injuries missed using physical exam alone.
4. DPL
   - -described by Root in 1965
   - -indicated in unstable patients
   - -very sensitive and specific for hemoperitoneum
   - -historically popular in U.S. Trauma centers
5. CT
   - -identifies specific organ injuries and fluid
   - -indicated in stable patients only
   - -Pt must leave ED
6. Prime Objective of Trauma Resuscitation
   - -"determine the need for laparotomy, not identification of --- specific organ injuries"
7. Ultrasound
   - -rapid
   - -non-invasive
   - -real time
   - -serial exams
   - -does not interupt the resuscitation
   - -no patient risk

Ultrasound

History

- -describe in the early 70'2 in the european literature
- -used in Germany, Japan, China, Netherlands, and Canada
- -development of small high quality portable machines allowed

for wide spread applications

Literature

sensitivity-free fluid

-85-98% depending on experience of sonographer

specificity-free fluid

-90-l 00% depending on experience of sonographer

-sensitivity for solid paranchymal injuries much lower

fluid quanitation

-250-500cc in morison's pouch

-difficult to quanitate width of fluid stripe

-qualitative estimation is probably all that is needed.

experience

-more exams-the better

-current evidence that 30-50 exams needed for consistent practice

-learning curve appears steep

Application

four view exam

-subxyphoid veiw

-right upper quadrant-morison's pouch

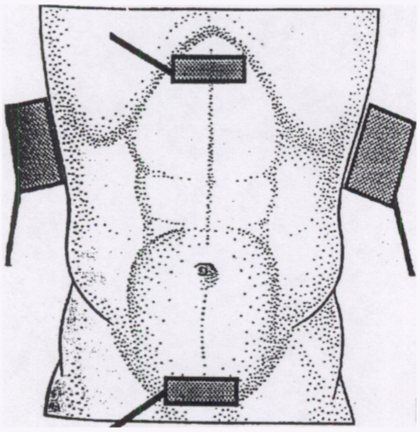
-left upper quadrant

-suprapubic view

augmented view

-pericolic

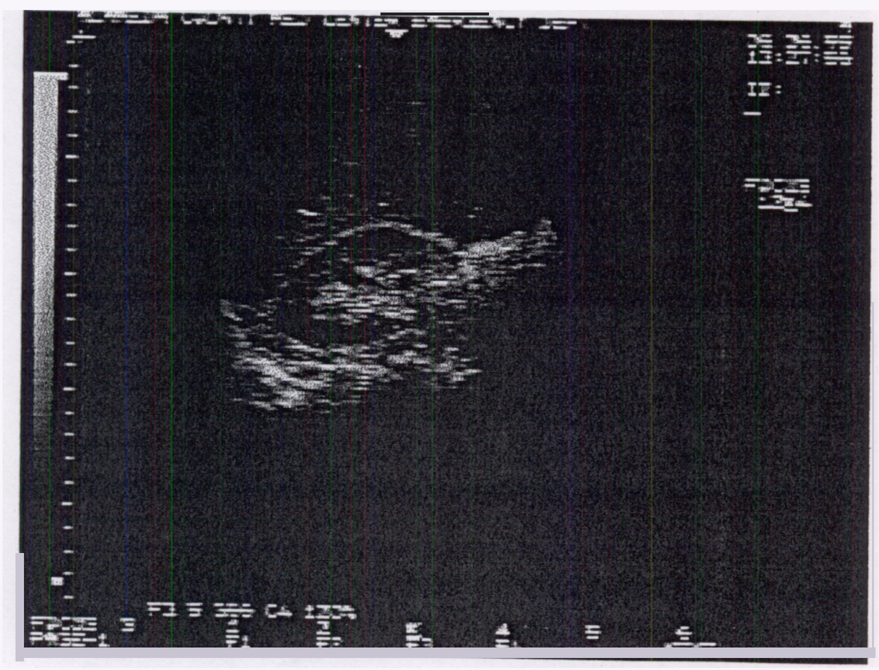
parasternal cardiac views


Four View Exam

RUQ (Morison’s Pouch)

Position transducer in the coronal plane at right 10th ICS. Oblique the transducer to fit between the ribs. The position marker will be towards the posterior axilla. As you fan back and forth you will want to find the hepatorenal interface (morison’s pouch) in its longest view. This will give the best view for fluid. The white line around the kidney is gerotta’s fascia.

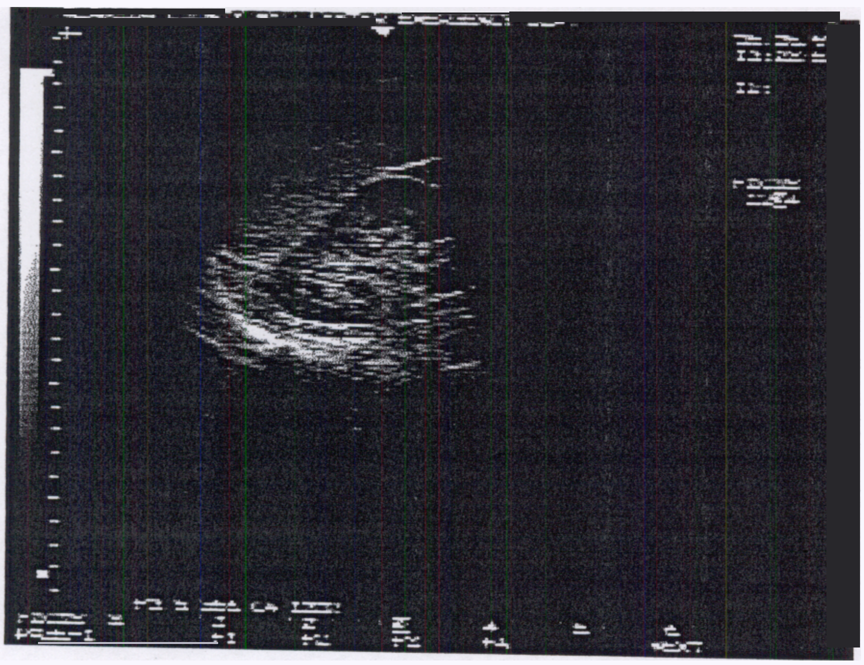
RUQ



LUQ View

Position the tranducer on the left in the coronal plane at the 10th ICS. This view is a bit more difficult because of bowel gas. Putting the transducer all the way torwards the posterior axillary line with your hand touching the bed is a good idea. Attempt to get a view of the splenorenal interface. It is important to remember that blood goes on top of the spleen in the subphrenic space because of the splenic ligament.

LUQ



Pelvic View

The pelvis should be viewed in both longitudinal and transverse. The long view can give more spacial orientation. Blood will be viewed on top of the bladder. Remember that the normal view is for bowel gas to obscure any view on the bladder. Bowel that is seen clearly generally represents fluid.

In the transverse view fluid accumulates perivesicular. In the female perlvis fluid accumulates in the puch of Douglas, the most dependent portion.

Cardiac View

The transverse subxyphoid view is the most common view. Using the left lobe of the liver as an acoustic window the transducer is place transverse under the xyphoid. The RV and LV can be seen and pericardial fluid appreciated. This can be an unreliable view with most convex transducers. The parasternal views can be easier in trauma patients for fluid checks. We recommend that you learn all of the views.

Ultrasound

Disadvantages

-operator experience-the most important
-difficult to detect solid organ injuries
-difficult in obese patients
-difficult with subcutaneous air

Important Pitfalls

-not recognizing fluid around the bowel
-failing to look suprasplenic for fluid
-failing to view morison’s pouch in multiple planes
-rushing the exam
-diagnosing parenchymal injuries

Conclusion

Useful adjunct in evaluation of trauma patients
DPL reserved for equivical or suboptimal cases
Best for free fluid and not parenchymal injuries

OB/GYN Exam

Technical Considerations

The standard obstetrica/gynecological exam involves imaging the pelvis in multiple planes using both transabdominal (TAS) and transvaginal (TVS) approaches. The basic premise of goal-directed sonography implies that there exists no standard exam. Images are to be used only as an extension of the traditional clinical evaluation in an attempt to correlate sonographic abnormalities with symptoms. The type and breadth of any imaging study should be dictated by the clinical setting and the information required. Exams should be done only when a gynecologic cause is highly suspicious. They should be performed to explore potential gross pathologies rather than subtle variations in anatomy. As with many laboratory and imaging tests, if there is a low (pretest) probability of discovering a problem. the chance that a positive study represents a false-positive is increased. It is therefore important to interpret all ultrasound findings against the clinical likelihood of disease.

Two techniques evolved for the evaluation of the pelvis: transabdominal (TAS) and transvaginal sonography (TVS). The former, TAS, relies on a lower signal frequency allowing for deeper penetration of tissue and a wider visual field. This makes spatial orientation easier, and allows the surgeon to see large structures or those lying outside the true pelvis. The basic scanning technique and screen orientation of TAS is analogous to that described under imaging of the abdomen. TVS utilizes a higher signal frequency which makes possible more detailed images of the pelvic anatomy, especially the adnexa. Several studies confirmed a greater inter-observer agreement using this technique. There are limits to TVS, however, and those include (1) the difficulty it presents the clinician in attempting to orient spacially and (2) the shallow visual field that it offers.

Use of TAS should generally precede TVS because it (1) aids the physician with spatial orientation and (2) offers a superior anatomic overview of the pelvis. TAS may also provide enough information to make TVS unnecessary. After a TAS exam, a patient often empties her bladder to prepare for TVS. Her TVS study provides more detailed images of abnormalities not as clearly imaged via TAS, including the adnexa or endometrium.

TAS

A full bladder greatly enhances TAS's sensitivity and resolution (1) providing a sonographic window that allows better imaging of the deeper pelvic structures and (2) decreasing the chance of interposing the bowel (which may produce artifact). The patient may either fill her bladder by ingesting fluids, or, medical personnel may insert a Foley catheter and fill the bladder in a retrograde manner. The latter technique is more reliable.

To prepare for the exam, place the patient in the supine position and apply an ultrasonic gel to the lower abdomen. TAS exploits two basic imaging planes: sagittal (long) and transverse. To view from the sagittal or longitudinal perspective, place the probe in the midline just above the pubic symphysis. The direction indicator should point toward the patient’s head. Screen orientation matches that of other abdominal scanning techniques. The top of the screen (see narrow angle of pie shape) depicts the probe and corresponds to the anterior surface of the abdomen. The left of the screen is cephalad and the right of the screen is caudad. The screen bottom (see wide part of pie shape) corresponds to the posterior surface of the abdomen. Rotating the probe 90o counter-clockwise produces the transverse plane. Here, screen orientation resembles that of a CT scan of the abdomen: the left side of image represents the patient’s right, the right side of image represents the patient's left. The top Of the Screen (probe) again corresponds to the anterior surface of the abdomen Further angling of the probe, either right and left in the sagittal plane; or, up and down in the transverse plane; produces the oblique planes. As a general rule, each structure should be viewed in at least two planes (long and transverse).

TVS

Unlike TAS, a full bladder may actually prevent adequate views of pelvic structures if TVS is used. Thus, the procedure is performed with the patient’s bladder empty. No known contraindications to TVS exist, except recent gynecologic surgery. The procedure can be performed during any part of the menstrual cycle or pregnancy, or in the presence of infection.

Prior to insertion, the probe must be covered with a protective sheath. To cover the surface, a condom or latex glove is filled with a small amount of ultrasonic gel. Air bubbles cause artifact. Running a finger over the probe surface and smoothing the gel removes the bubbles. The patient is placed in the lithotomy position. preferably using a pelvic table. If a regular table is used, lift the patient's hips with a hed pan or pillows. Doing so allows easier manipulation of the probe. Prior to vaginal insertions, lubricate the condom-ensheathed probe with ultrasonic gel or Surgilube. Because ultrasonic gel may impair sperm motility. water may he substituted for patients whose fertility is of concern

The two basic imaging planes in TVS are the sagittal (long) and coronal. The probe is introduced into the vagina with the direction indicator pointed anteriorly toward the pubic symphysis. Advance the probe slowly toward the cervix while monitoring the projected image on the screen. The first image is normally the anteflexed uterus in the sagittal plane. In the early stages of learning TVS, screening orientation can prove confusing because the probe surface is no longer in the familiar anterior-posterior plane. It is important to remember that the top of the screen (small part of cone) always corresponds to the probe surface. However. in TVS, the probe surface lies in the vertical plane of the perineum, perpendicular to the planes used in TAS. The left side of the screen corresponds to the anterior surface of the abdomen while the tight side of the screen represents the posterior surface. The bottom of the screen extends deep toward the abdominal cavity and the patient's head. It is important to remember that the top of the screen (small part of cone) always corresponds to the probe surface. However, in TVS the probe surface lies in the vertical plane of the perineum. perpendicular to the planes used in TAS. The left side of the screen corresponds to the anterior surface of the abdomen while the tight side of the screen represents the posterior surface. The bottom of the screen extends deep toward the abdominal cavity and the patient's head. Oblique views are obtained by angling the probe toward the right or left of the patient to visualize the adnexa.

The coronal view is produced by rotating the probe 90 degrees counter-clockwise so that the direction indicator points toward the patient's right. In this position, the probe may he angled anteriorly or posteriorly to give semi axial planes. Angling the probe laterally will provide the tight and left oblique coronal views. Fine tuning of the images is achieved by varying the depth of the probe within the vagina and adjusting image magnification: Screen orientation is similar to standard TAS transverse views: the left screen corresponds to the patient's right, the right screen represents the patient's left. The bottom of the screen extends towards the head. Keep in mind that the top of the screen (see' small pie shape) lies in the plane of the perineum. Some ultrasound machines are equipped with a slanted surface vaginal probe, making it difficult to fully visualize tbe left adnexa. One solution to this dilemma is to rotate the probe 180o so that the slant faces toward the patient's left. Be mindful that right-left scene orientation is now reversed. Correct the view by activating the image reverse function present on most modem machines.

Normal Anatomy

Given the complex spatial relationships of the various structures of the pelvis, a thorough understanding of normal anatomy is essential to obtain a clinically useful study. One must also realize that normal female anatomy is highly dynamic, subject to cyclic or age specific hormonal effects. The physician should anticipate and interpret sonographic findings in light of the individual menstrual and hormonal environment. For example, endometrial thickening may be normal in the proliferative phase of a young women's menstrual cycle while indicative of dysplasia in the postmenopausal patient

The pelvis is divided into the true pelvis and false pelvis. The division is defined by the sacral promontory and the linea terminales (ilium arcuate line, the iliopectineal line and the pubic crest). As a general rule, the short focal length of TVS limits its use to structures located within the true pelvis, approximately IO cm from the tip of the probe. Large structures or those outside the true pelvis may be incompletely visualized with TVS. For viewing these structures, TAS stands as the preferred viewing method because of its greater tissue penetration and focal length

Uterus and Cervix

In the Pelvis, the views of the uterus are easily obtained, and may he used as a reference point throughout a study. Solid, and pear-shaped, the uterus lies between the bladder anteriorly and the rectosigmoid colon posteriorly. Uterine size and appearance varies with pubertal stage and parity. The base of the uterus (closest to the probe with TVS) is the uterine cervix, which anchors the structure at the angle of the bladder. The angle the cervix makes with the vagina is referred to as version. The angle the uterine body makes with the cervix is referred to as flexion. The most common relationship is anteversion and anteflexion resulting in a near vertical orientation of the uterus in the supine patient.

The relatively fixed cervix is extraperitoneal while the more mobile uterus is covered by peritoneum. Tbe broad ligament is a peritoneal sheath coveting the uterus, surrounding the adnexa and the vasculature and serves as a support structure for the uterus. Reflections of the peritoneum anterior and posterior to the uterus form recesses: they represent the vesicouterine pouch and pouch of Douglas (cul de sac), respectively. A small amount of fluid in the pouch of Douglas is normal and appears as a clear anechoic area immediately posterior to the uterine cervix Heterogenic echoes within the fluid suggest clotted blood or purulent material. Fluid in the anterior vesicouterine pouch implies large volumes, typically indicating ascites or hemoperitoneum. Occasionally, bowel may intercede in the pouch of Douglas and can be recognized hy its characteristic gas artifact and peristalsis.

The uterine myometrium possesses a medium echogenicity on ultrasound. This is set against the highly echogenic endometrial stripe which marks the anatomic center of the organ. Arcuate arteries may also be visualized in the outer myometrium as small, regular areas of decreased echo signal (see figure On TAS long, the uterus is pear-shaped, lying immediately posterior to the fully distended bladder. In the transverse plane, the uterus is elliptical with the tell tale endometrial stripe running transverse in the long axis. Thr ovaries are typically seen lying just lateral to its walls. The TVS long view is analogous to the TAS long except that the probe tip (top of screen) is adjacent to the cervix. On TVS coronal, the uterus again appears as an ellipse.

Endometrium

As mentioned above, the normal appearance of the endometrium depends on the hormonal environment and menstrual phase During the proliferative phase of the menstrual cycle, the endometrium gradually adds thickness and contrast relative to the adjacent myometrium. In the secretory phase, the endometrium becomes more homogenous, and less echogenic until menses occurs. The thickness of the endometrium is best measured in the TAS long from anterior to posterior. Greater than 10 mm of endometrium in a postmenopausal patient is abnormal even in a setting of hormone replacement. Such thickening may indicate dysplasia. In contrast, in the gravid patient, endometrial thickness is normally increased. Failure of the endometrium to thicken may indicate an abnormal pregnancy. Less than 8 mm of endometrium was 97 % predicative of abnormal pregnancy in patients with beta-HCG greater than 1000.

Fallopian **Tubes**

Anatomically, the fallopian tubes are located just below the fundus of the uterus, appearing to taper off the cornua toward the lateral walls. The normal tube is approximately 0.1-3 mm in diameter and IO cm long. The medial portion of the tube is the largest and typically the only visible section on ultrasound. In the non-pathologic state (nondilated, not surrounded with fluid), the remainder of the fallopian tube is not seen.

Ovaries

The ovaries are oval shaped structures of medium echogenicity which lie immediately adjacent to the lateral walls of the uterus. Begin by locating the midline of the uterus on TAS long and then angling the probe obliquely just past its lateral walls. The ovaries are discrete, usually heterogenic structures which may appear almost contiguous with the myometrium. A second useful landmark for localizing the ovary is the internal iliac artery (16). The artery is easily recognizable by its cylindrical shape and pulsatile image. Predictably. the ovary can be found immediately to the anterior and medial side of the vessel. As with all the reproductive organs, their appearance and size varies greatly with changing hormonal stimulation (see Figure 16). The average adult ovary measures 2.5-5.0 cm in length and 1.5-3.0 cm in width 12). In the menstruating patient. the presence Of internal follicles can greatly facilitate the visualization of the ovary. In contrast, postmenopausal ovaries are more difficult to recognize since they are smaller, atrophic, and lack the tell tale internal follicles.

I* the early proliferative phase of the menstrual cycle, typically 5 to 11 follicular cysts may dot the parenchyma of the ovary. Near mid-cycle, a dominant follicle develops which maybe 1.5-2.0 cm in diameter, nearly doubling the size of the “vary Following rupture of the dominant follicle and successful ovulation, a corpus luteum may be seen in the ovary in up to 50 % of cases. It appears as an irregular cystic structure with echogenic content. usually blood. The corpus luteum persists throughout the secretory phase hut should not be visible beyond 72 hours into the next cycle (14). A small amount of fluid in the cul de sac is commonly seen around the time of ovulation and represents the released contents of the dominant follicle (15). The irritation associated with accumulation of this intraperitoneal fluid is generally regarded as the origin of the mid-cycle pain known as mittleschmerz.

Basic Ultrasound- The Machine, Technology and Technique.
John S. Rose, M.D.

I. Course Introduction

1. The introduction of real time bedside ultrasonography has revolutionized the practice of emergency medicine. Ultrasound has been incorporated into the practice of many emergency physicians.

2. Emergency department ultrasound is **limited, goal directed exam** used to answer a specific clinical question. It is not necessarily comprehensive nor does it replace a formal sonography. It can be considered an extension of the physical exam.

3. Understanding the machine, physics and applications is essential to the safe and accurate practice of emergency department ultrasound.

II. Objectives

A. At the conclusion of the session participants will:

1. Describe the basic physics and knobology of real time pulsed ultrasound.

2. Understand image orientation.

3. Describe various scanning protocols for common ED applications:
   Right upper quadrant
   Aorta
   Trauma
   Pericardium
   Pelvic

III. Outline

A. Physics and Knobology

1. Piezoelectric effect- The generation of an ultrasonic wave impulse is achieved through the piezoelectric effect (pressure electric.) This phenomena was first noted by the Curie's at the turn of the century. In simple terms, the piezoelectric effect is the phenomena where a crystalline material with a dipole moment vibrates at given frequency when an alternating current is applied.
2. Pulsed ultrasound- Pulsed-echo mode is used for most ED ultrasonic applications. In this mode the crystal generates an ultrasonic signal for a given period and then acts as a receiver for a period of time; the crystal acts as both signal generator and receiver.
3. Impedance/Attenuation-Reflection of the sound occurs at this interface The amount of reflection is dependent upon the acoustic impedance of the object. A very dense object such as bone has very high acoustic impedance and reflects all of the sound, leaving an anechoic, or echo-free image on the monitor. An object of lower uniform density, like the liver, will reflect a proportion of the sound and transmit the remainder. Attenuation is the diminution of the signal energy as it passes through a medium.
4. 2-D imaging- The ultrasound image is only a two-dimensional cross-section. To develop a spacial or 3-D perspective of an object one must scan in several perpendicular cross sections.
5. Resolution- Resolution is the minimum reflector separation required to produce separate reflections in a pulse-echo system. There are two types of resolution in pulsed-echo ultrasound: axial resolution and lateral resolution. Axial resolution is the minimum reflector separation along the sound path. Lateral resolution is the minimum reflector separation across, or perpendicular, to the beam path. Lateral resolution is dependent upon the beam width.

Artifact-a few of the common artifacts include

1. **Shadowing** results when an object of sufficient density blocks the transmission of the signal. The area behind the object is

seen as having less transmitted signal when compared to the surrounding tissue .

2. **Edge artifact** is a type of refraction artifact that results from the bending of the signal beam as it makes contact with large curved structure. It is analogous to the apparent bending of a knife when it is placed in a glass of water. The edge of the object appears to shadow and become distorted. Edge artifact can be falsely interpreted as an acoustic shadow resulting from a dense object such a gallstone.
3. **Comet tail** artifact occurs when multiple internal reflections resonate in a small highly reflective surface. Comet tails generally occur in relatively echo free areas).
4. **Reverberation** is artifact which results from multiple reflections at an interface. It most commonly occurs at interfaces where the acoustic impedance is large. Reverberation is a very common artifact and frequently occurs when the gain is turned up to “see through” gas creating more echoes.

B. Machine Characteristics

1. The Ideal ED machine- The ideal ED ultrasound machine has yet to be developed. Most machines currently are for limited office use and rarely leave the location where they are placed. A typical ED machine is moved from bedside to bedside, frequently in a hurried fashion, and subject to generalized physical abuse. In purchasing a machine the overall durability should be considered along with technical specifications.

2. Be cautious about accepting a used machine from another department. Frequently these machines are worn, large, and contain more features than you will need. The current market of portable ultrasound machine offer a wide array of features and capabilities at very affordable prices. It is more prudent to invest in image resolution rather than extra features that you may never use.

3. Assess the needs of your department. Will you be doing echocardiography? Do you wish to incorporate endovaginal

ULS? Do you wish to generate video images and still thermal images? After an assessment of applications has been made it is time to select a machine. Most ultrasound vendors have portable machines which meet the needs of emergency and ambulatory ultrasound. Solicit literature and demonstrations from several vendors. Use your own application person if possible to allow for a more uniform evaluation.

4. Ultrasound machines used in the emergency department or ambulatory setting have a few special requirements. Look for machines that have few moving components as the daily wear and tear in an ambulatory department will quickly break loose components. The machine should be small enough to allow one staff person to easily move it from room to room. Assure that the probes are secured and protected well.

5. Get the names from vendors of departments who are using their machine in similar application to yours. If you work in an emergency department get a list of other ED's using their particular unit. Questions to consider when purchasing an ultrasound machine include:
    A. What types of transducers are available?
    B. What is the service warranty?
    C. Is staff training included in the purchase?
    D. Do other emergency departments or ambulatory locations utilize this particular unit?

Technical specifications of an acceptable ultrasound machine include:

Grayscale minimum of 64 shades
Multiple ports for transducers
Sealed keyboard
Minimum 9-inch monitor
minimum 64-channel beam formation
Output to thermal printer or video
Measurement capabilities

C. Transducers

1. Ultrasound transducers are the probes which contain the collection of piezoelectric elements used for ultrasound

transmission. There are many different styles of transducers available. The particular sonographic application desired will determine the type of transducer needed.

2. In **mechanical probes,** the piezoelectric elements are mechanically steered, or wobbled through the scanning area. The sector images is produced as the elements sweep through the scanning zone. These probes are less expensive but possess a level of physical wear and resulting replacement costs.

3. The second style of transducers are the **electronic type.** With advent of sophisticated electronics and miniaturization over the past twenty years, highly, accurate and reliable electronic transducers have been developed.

   Linear array transducers has the piezoelectric elements linearly arranged and sequentially activated to produce an image.

   A **phased array transducer** groups the piezoelectric elements in a smaller scanning surface. The elements are activated with small timing (phase) differences which allows the steering of the ultrasound signal.

D. Monitors-

1. Objects close the skin and transducer head **are** termed **near-field** and are on the upper portion of the monitor. Objects deeper on the screen are termed **far-field.**
2. Each transducer has a reference marker at one end of the array which coincides to a screen marker These markers allow for orientation of the ultrasound image.

E. Terminology

1. Gain/TGC-Modulate the amount of received echo. Similar to a volume knob. TGC is gain adjustment at various depths.
2. <u>Longitudinal-</u>scanning plane oriented cephlad-caudad. Position marker towards the patient's head.
3. <u>Transverse-</u>scanning plane oriented right to left. Perpendicular to longitudinal plane.
4. <u>Coronal</u>-scanning plane from patients side oriented longitudinal.
5. <u>Position marker-</u>identifying mark on a transducer allowing for orientation.

6. Near/Far field-near field is the top of the monitor or closest to the surface. Far field is the bottom of the monitor or furthest from the surface.
7. Acoustic window-a scanning plane that allows for accurate acoustic interrogation of deeper structures (i.e. liver or bladder)
8. Dead zone-the first few millimeters from the transducer that are acoustically silent.
9. B mode/ M mode-B mode is the 2-D scanning plane most commonly used. M mode takes one piezoelectric crystal from the B mode and plots it against time.

F. Applications

1. RUQ-the primary application in the right upper quadrant is to detect the presence or absence of gallstones. An evaluation of the common bile duct is useful as one gains more technical skill. The gallbladder is visualized in 2 or 3 different planes -longitudinal, transverse, and coronal.
2. Hemoperitoneum-The trauma hemoperitoneum evaluation is a 4-6 view exam. Generally a single pericardial view; hepatorenal interface (Morison's pouch); splenorenal interface; pelvis; and pericolic gutters.
3. Aorta- can be visualized in both longitudinal and transverse view. Primary measurement is in the transverse plane. It should be evaluated from subcostal area until it bifurcates at the iliacs.
4. Pelvic-the primary focus of ED ultrasound is IUP identification. Presence or absence of a viable IUP is the primary focus. The adenexa are visualized but a comprehensive evaluation can be quite difficult.
5. Cardiac-a single or multiple view of the heart evaluating for pericardial fluid or qualitating cardiac activity is the goal of ED ultrasound. Any of the four standard views can be used.

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Advanced Ultrasound
John S Rose, M.D.

I. Course Introduction

1. Emergency Physicians have been gaining experience and depth in their practice of limited, goal directed ultrasound.

2. Several issues have arisen as ultrasound gains more prominence.

3. Current implementation issues, pitfalls, and novel applications are all areas in advanced ultrasound

II.Objectives

At the conclusion of this lecture, participants will:

1. List the 5 Tenets of ED ultrasound.

2. Understand current issues of credentialing, trauma and outcomes research.

3. Describe the common pitfalls in limited ultrasound use.

4. Describe the novel uses of ultrasound for line placement, DVT, abscess identification, foreign body.

III.Tenets

A. Understand limited, goal directed exam

B. Use accepted scanning protocols

C. Practice, practice, practice

D. Record and review

E. Educate your patients

IV. Issues from the Front

A. Credentialing

1. No national credentialing although some movement by the AIUM Board of Governors for national standard.

-AIUM
500 exams/100 hours CME

-SAEM
150 exams/ 40 hours CME

-ACEP
support residency ultrasound education

-ACS
FAST curriculum certification
in development

-CMA resolution
California Medical Association recently passed resolution that, for ultrasound, the professional societies should determine requirements.

-ACC
Recent position paper on echo that emergency physicians should not be doing “quick looks” for fluid.

-JCAHO
Concerns many because of uniform practice issue in the hospital. UC Davis model most logical but not yet proven.
Level I-limited
Level II-Focused, Comprehensive(echo)
Level III-Comprehensive (radiology)

B. Trauma

1. ACS developing curriculum for FAST exam.
2. Probably the best area for collaboration although surgeons have the lead.
3. Will this be another merit badge?

C. Outcomes research

1. Most needed ultrasound research
2. Mateer, Valley Endovaginal ultrasound study: Ann Emerg Med March 1994-a first.
3. Recent ACMC trauma study-Randomized controlled trial

Aca Emer Med May 1999.

4. Sonographic Outcomes Assessment Protocol-SOAP Multicenter, Randomized, Trauma registry, Surgery and Radiology involved.
5. ED ultrasound registry-O. John Ma

V. Pitfalls

Cases

1. Pelvic
   a. 23Yr female lower abd pain. Positive Pregnancy
   b. 30 yr female RLQ pain. Negative pregnancy
   c. Take home points from cases

2. Trauma
   a. 25 yr male MCA. Altered. Hypotensive in field-ok now.
   b. 31 yr male MVA. Periumbilical pain.
   c. Take home points from cases

3. RUQ
   a. 48 yr female with epigastric pain. Afebrile. Labs ok.
   b. 44 yr female periumbilical pain. Temp 100.7F. Labs ok.
   c. Take home points from the cases.

VI. Novel applications

1. DVT
   a. Compression testing at femoral/popliteal area.
   b.Just compression testing has a 90% sensitivity

2. Deep brachial vein
   a. Reproducible access site
   b. Need 2 inch angio cath
   c. Great technique!

3. Foreign body
    a. Limited success
    b. No clear indication

4. Abscess identification
    a. Some mixed results
    b. Yet to be verified
    c. Variable echogenicity

VII. Conclusion

In this lecture we covered some important points involved in the advanced application of ED ultrasound. The 5 Tenets, Credentialing, Trauma, cases illustrating important pitfalls, and novel applications were all discussed.

Selected Annotated Bibliography

EM Ultrasound texts

Heller M, Jehle D: Ultrasound in Emergency Medicine. Philadelphia, WB Saunders, 1995.

*The first ultrasound text by emergency physicians. A very good overview book with a lot **of** insight.*

Simon B, Snoey E: Ultrasound in Emergency and Ambulatory Care, Mosby, 1996.

*Written by emergency physicians as a how-to text. Focuses on practical aspects **of** ED ultrasound with tips and techniques.*

Radiology texts

Rumack C, Wilson S, Charboneau J: Diagnostic ultrasound. 2nd Edition, Mosby, 1998.

Sanders RC: Clinical Sosnography: A Practical Guide. Boston, Little Brown, 1984

A very good text to learn basics.

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