

Guide to the Ultrasound Examination of the Abdomen

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Introduction and User's Guide

Abdominal ultrasound examinations are now performed mainly with real-time instrumentation, thereby giving the user tremendous flexibility in the manner in which the examination is conducted. However, with such flexibility come significant problems as well. Because fields of view are small, and because the operator can readily move the probe anywhere in the abdomen to see structures in a variety of planes and sections, it is relatively easy to become disoriented or to miss significant findings unless the examination protocol is carefully devised. The operator must approach the task of scanning the patient in a logical and organized way that is related to the patient's clinical findings as well as to the findings discovered during the ultrasound examination.

This book has been written to assist the operator in performing an organized and directed ultrasound examination by providing in outline form a sequential approach to the scanning of abdominal organs and regions. This approach has several functions: 1) to indicate the structures within the organ or region that should be scanned; 2) to suggest other regions to examine if abnormalities within the initially imaged structures are detected; and 3) to suggest differential diagnostic possibilities when abnormalities are seen.

The approach used in this book differs from that of most other ultrasound texts in that abnormalities are first characterized by their ultrasound findings and then associated with disease processes rather than the reverse. Such an approach is quite practical because when an examination is being performed or interpreted, the operator begins with ultrasound findings and then deduces disease processes.

The book is divided into chapters relating to major intraabdominal organs or regions, and to specific clinical problems. Within almost all of the chapters the organization is as follows:

- 1) A table of contents listing the major subdivisions of the chapter.
- 2) An **OVERVIEW** section, which is an outline of what is within each subdivision. This overview is designed so that the user can rapidly assess what regions must be examined and what to expect to find. If abnormalities indicated within the Overview section are discovered, the user can refer to specific pages for detailed descriptions. If no abnormalities are found, then the user usually has no need to refer further within the chapter.
- 3) Detailed descriptions of the various subdivisions briefly presented in the Overview section. These sections are organized such that the major ultrasound findings are presented as boldfaced headings along

the outside margin of the page with detailed descriptions adjacent.

4) **SCAN TIPS**, a section of particular note within most chapters which describes a variety of suggestions for improving the quality of ultrasound images.

5) Special symbols and terms that are frequently used:

✓ means "check for or seek associated findings that may be present."

CAUSES OR CONSIDER refers to diagnostic possibilities suggested by the preceding ultrasound findings.

Because the book is designed as a reference text to assist the user with a particular clinical problem or ultrasound finding rather than to be read cover to cover, it was structured so that most or all of the information relating to a particular clinical problem or ultrasound finding is presented on the same or adjacent pages within the chapter. Even though the book becomes larger from repetition of certain regions of text, this format was used so as to make the desired information rapidly available to the reader, and reduce or eliminate the need to refer back and forth to different chapters to find all of the pertinent data.

The book is intended to be used by the operator during the performance and review of the ultrasound examination. Line drawings rather than photographs have been used to illustrate points. Line drawings do not become dated whereas photographic illustrations may become outdated as improved scanners produce better images. Likewise, the absence of a section on obstetrics is intentional since it would add considerably to the size of the book. A separate work devoted to this topic is planned.

The material within this book is based upon the author's clinical experience and reading of the literature. This material is not meant to be all-inclusive. If significant omissions or inaccuracies have occurred, the author would appreciate being informed.

MLS

March 1986

Squirrel Hill

Pittsburgh, Pennsylvania

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History

- Prior ultrasound study
- Surgery
- Trauma
- Known inflammation/infection
- Medications

Scan Tips

- Belly out—deep inspiration maneuver
- Probe pressure
- Scan in perpendicular planes
- On fly photography

Abscess Characteristics

- Mass effect—appearance variable
- Anechoic/hypoechoic/hyperechoic
- With/without acoustic enhancement
- Shadowing within mass
- Anterior wall—no posterior wall
- Fluid/fluid level

Regions to Examine

- Solid organs
- Potential spaces
- Palpable masses
- Surgical sites
- Diaphragm and lung bases

Distinguish From

- Fluid in bowel
- Intraperitoneal fluid
- Retroperitoneal fluid
- Fluid-filled masses
- Intraperitoneal mass

Fine Needle Aspiration

- To obtain sample of fluid collection/mass for characterization of contents (Details, see Chapter 4)

- Reasons for study
- Organs scanned
- Results
- Date and facility where examination performed
Present location of films and reports

Prior Ultrasound Study

- Procedure performed
- Location of incision and drain sites on skin

Surgery

- Site of injury

Trauma

- Pancreatitis
✓ Infected pseudocyst
- Pyelonephritis
✓ Renal/perinephric abscess

Known Inflammation/Infection

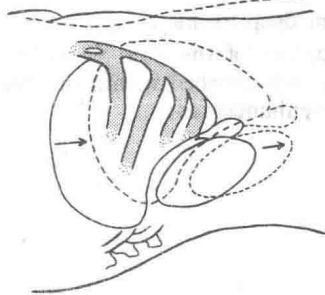
- Steroids/immunosuppressive therapy
May mask signs/symptoms of abscess

Medications

- Peritoneal dialysis
- Ventriculoperitoneal shunt

Other**Scan Tips**

- To cause downward displacement of liver, kidneys, spleen, pancreas, gallbladder below rib cage so as to facilitate scanning.
- **Belly out**—patient pushes out anterior abdomen by contracting diaphragm. [Fig. 1-1]
- **Deep Inspiration**—patient takes deep breath. Rib cage expands. Diaphragms contract.
- One maneuver may be more effective than another for a given patient.

Belly Out/Deep Inspiration Maneuvers**Fig. 1-1**

Probe Pressure Improves Image

- Increasing probe pressure on skin may improve image quality. Tissues between skin and region of interest are compressed, thereby reducing artifacts within region of interest from reverberations and refractions of the ultrasound beam.
- Do not press hard enough to cause patient discomfort—Inquire of patient if pressure too great.

Scan in Perpendicular Planes

- Scan suspected abscess in two planes perpendicular to each other to distinguish a real mass (having volume and seen in two perpendicular planes) from an apparent mass (seen in only one plane). [Fig. 1-2]

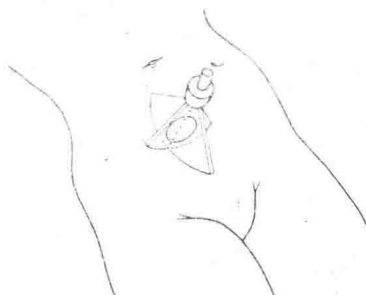


Fig. 1-2

On Fly Photography

- To improve image quality by reducing random noise within image and enhancing echoes containing real data.
- Image photographed without first freezing frame. Operator holds probe motionless. Patient suspends respiration prior to exposure.
- If patient cannot suspend respiration, exposure made at end respiration (when normal breathing pause occurs).
- Camera setting: approximately 1/4- to 1/2-second exposure. NOTE: difficult to use multiimage camera that first calibrates itself on a blank screen because total exposure time becomes too long for patient and probe to be motionless.

Abscess Characteristics

Anechoic/Hypoechoic Mass

- With or without acoustic enhancement deep to mass
NOTE: The greater the protein content of the fluid within the mass, the greater the amount of sound absorbed within the fluid and the weaker the distal acoustic enhancement
- Wall appearance variable
Smooth/irregular
Thin/thick

- Mass predominantly hypo/anechoic
- Hyperechoic foci may represent:
 - Flecks of debris within abscess
 - If multiple masses and patient immunosuppressed, consider candidiasis
 - Gas from gas-forming bacteria within abscess
 - Absence of shadowing may occur because collection of gas is too small to block enough of sound beam to cause shadowing

Hyperechoic Foci Within Mass

- May show deep acoustic enhancement
- Usually no deep acoustic shadowing
- Causes of increased echoes within abscess
 - Gas microbubbles diffusely distributed in abscess
 - Mixture of necrotic tissue, debris, and fluids of different density and reflectivity

Uniformly Hyperechoic Mass

- Gas-forming bacteria within abscess
 - If gas collection large, may see only anterior wall of mass [Fig. 1-3]
 - Rescan with horizontal beam (either with patient remaining supine and beam entering from flank [Fig. 1-4] or with patient decubitus [Fig. 1-5] to determine if there is a fluid layer below gas
- Foreign body within abscess
 - Surgical—sponge/clips/catheter
 - Traumatic—wood/metal/glass/cloth
- Calcifications within abscess
- If cause of shadowing not clear from ultrasound, consider CT or x-ray

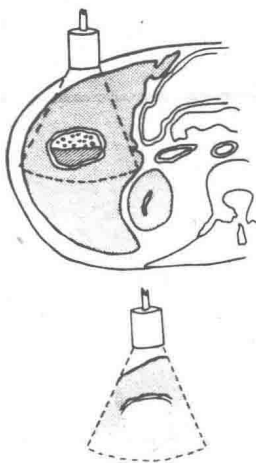
Acoustic Shadowing from Mass

Fig. 1-3

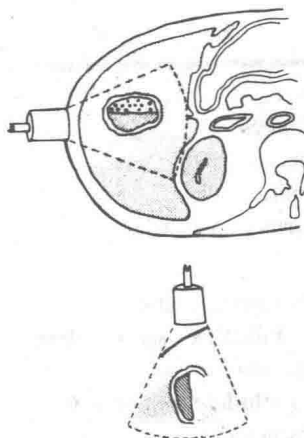


Fig. 1-4

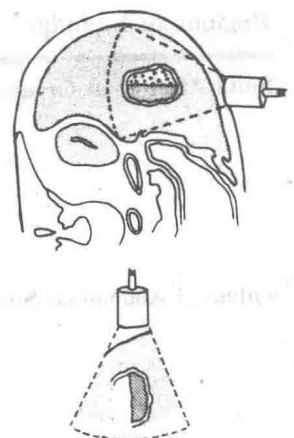


Fig. 1-5

6 Abscess Characteristics

Mass with Fluid/Fluid Levels

- Interface remains horizontal (gravity dependent) when patient shifts from supine [Fig. 1-6] to decubitus [Fig. 1-7] position
- Dependent layer usually echogenic

Note

- Abscesses are not ultrasonically distinguishable from noninfected fluid collections or certain solid masses
- Consider fine needle aspiration to confirm or exclude a suspected abscess (Details, see Chapter 4)

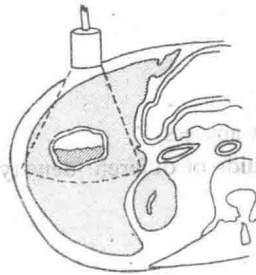


Fig. 1-6

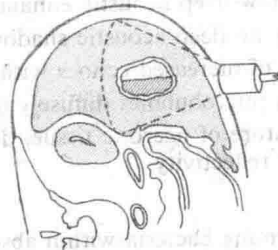
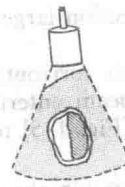


Fig. 1-7



Regions to Examine

Solid Abdominal Organs

- Liver
- Kidneys
- Spleen
- Pancreas
- Uterus and ovaries

Potential Abdominal Spaces

- Subdiaphragmatic
 - Difficult to see if spleen small or absent
- Subhepatic
 - Include periocholecystic
- Subsplenic
- Lesser sac

- Lateral gutters
- Perinephric
- Para-aortic
- Cul-de-sac

Distinguish from fluid in bowel or bladder

- Palpable masses
- Incisions/drain sites/stomas
- Tender or painful regions
- Lung bases—pleural effusions

Other Abdominal Regions

Diaphragms

- Compare diaphragm motion bilaterally
- If little or no diaphragm motion with normal or deep inspiration, have patient sniff to accentuate motion

Scan Tips

- Bilaterally symmetric motion
- Each side moves several centimeters

Normal Motion

- Chest causes

Phrenic nerve injury
Pleural effusion
Pleural fibrosis—may see pleural thickening
Pneumonia/pulmonary infarct
Recent surgery or trauma

Reduced Motion

- Abdominal causes

Ascites
Tumor or abscess limiting liver or spleen movement by invading adjacent structures
Pain from inflammation or abscess limiting movement
Cholecystitis/hepatitis/pancreatitis/pyelonephritis/peritonitis
Recent surgery/trauma

Distinguish From

Bowel

- Peristalsis may be present
- Mucosal markings may be seen
- Lumen collapses with increased probe pressure
- Appearance of bowel contents changes following oral or rectal instillation of air or water

Fluid-Filled Nonobstructed

8 Distinguish From

Abscess Search

Fluid-Filled Obstructed or Ileus

- Lumen dilated
- Peristalsis usually absent
- Mucosal markings either very distinct or effaced if lumen markedly dilated
- Lumen may not collapse with probe pressure
- Appearance of contents does not change following oral or rectal instillation of air or water
- Respiration may cause to-and-fro movement of contents within lumen—not peristalsis
- **May not be able to distinguish from abscess without fine needle aspiration of contents**

Focal Wall Thickening

- Involved bowel loop usually appears as tubular mass
 - Fusiform in one plane
 - Circular in 90° plane
- Fixed shape
- Lumen may contain gas or liquid bowel contents
 - If gas—see central acoustic shadow within thickened walls
 - If fluid—see hypo/anechoic central region within thickened walls
- Contents often change from gas to liquid or reverse during observation
- Causes
 - Inflammation
 - Edema
 - Tumor

Intraperitoneal Fluid

Free

- Contours of fluid configured to margins of adjacent organs
- Fluid contours may form acute angles with adjacent organs
- Fluid may shift when position of patient is changed
- Fluid compressible with probe pressure
- Fluid usually echo free
- If echoes or mobile filaments within fluid, consider:
 - Pus from peritonitis
 - Blood from intraperitoneal hemorrhage
- Distinguish subdiaphragmatic fluid from pleural effusion (Details, see Ascites Search, pg. 12)

Loculated

- Contours usually convex
 - Do not configure to adjacent organs
- Fluid noncompressible/nonshifting
- Appearance usually anechoic or hypoechoic
- If multiseptate appearance (anechoic/hypoechoic pockets within hyperechoic matrix), consider hematoma

- Contours usually convex
- Fluid noncompressible/nonshifting
- Anechoic or hypoechoic with or without deep acoustic enhancement
Consider: urinoma/lymphocele/hematoma
- Multiseptate with anechoic/hypoechoic pockets surrounded by hyperechoic matrix

CONSIDER: hematoma

Retroperitoneal Fluid

- Contours usually convex
- Fluid noncompressible/nonshifting
- Usually anechoic with deep acoustic enhancement

Fluid-Filled Masses

• CONSIDER:

Cysts—renal, hepatic, ovarian, mesenteric, lymphangitic

Bowel duplication

Pancreatic pseudocyst—may dissect along tissue planes, can contain echoes, with or without deep acoustic enhancement

- Nodular, sheetlike, or irregular echogenic masses lying adjacent to abdominal wall
- May cause localized indentations of surfaces of solid organs or displace bowel
- Noncompressible/nonshifting
- Ascites may also be present

Intraperitoneal Masses

• CAUTION:

Do not confuse reverberation echoes that may be seen just below the abdominal wall in ascites at high gain settings with an intraperitoneal mass

Reverberation echoes are the same thickness as the abdominal wall, do not displace organs, and change appearance with slight change in orientation of the probe to the abdominal surface

• CONSIDER:

Mesenteric mesothelioma

Pseudomyxoma peritonei

Metastatic tumors—often from ovary or bowel (including stomach)

- Ultrasound appearance cannot distinguish between sterile and infected fluid—consider fine needle aspiration (Details, see Chapter 4)

Fine Needle Aspiration

Abscess Characteristics

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Distinguish From

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