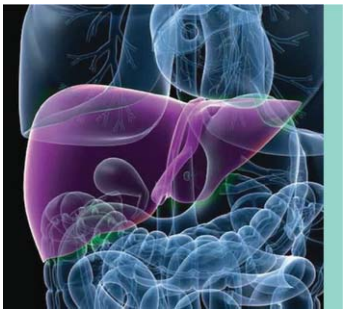

Examination of the Abdomen

Adrian Reuben, M.B.B.S., F.R.C.P., F.A.C.G., F.A.A.S.L.D.

Among the major anatomical regions of the body, the abdomen—bounded above by the thorax and below by the pelvis—is something of a paradox in terms of the accessibility of its contents, despite the fact that its anterior approach is soft and pliable when relaxed and its organs are not diminutive. Generally, the normal abdominal viscera are not detectable on physical examination, with the possible exceptions of a liver that is pushed down below the costal margin by a diaphragm that is depressed by thoracic disease (such as emphysema and scoliosis), or the pulsations of the descending aorta in an individual who is constitutionally or pathologically thin, in whom incidentally the kidneys and the inferior margin of the liver may occasionally also be felt. In contrast, in the current climate of prevalent obesity, pathologically enlarged intra-abdominal organs or fluid, or both, may not be detected at the bedside in a belly that is distended with central adiposity. The notion that organs as large as the liver, kidneys, and intestines are usually impalpable is embodied in the etymological origin of the word *abdomen* that is derived from the Latin *abdere*, meaning ''to hide.'' It is ironic that the lay term *belly*, derived from the Old English *belg*, that is, a bag, implies protuberance, distension, or swelling, as expressed graphically in the plural noun *bellows* and the verb *to billow*. Strictly speaking, the liver lies in the thorax, below the dome of the right hemidiaphragm, where it can be detected by percussion; but it has more in common anatomically and functionally with the organs of digestion and the spleen than with the lungs and the heart, which for the latter the liver provides a supportive platform.

Cross-sectional, dynamic, and the other methods of abdominal imaging are nowadays thought by some to supplant physical examination, but the latter should still be a prelude to imaging. Physical findings, together with the history, may guide the choice of imaging and its interpretation, and give some positive and/or negative clues to the diagnosis that ultrasonography, computed tomography, magnetic resonance imaging, and nuclear isotopic scanning cannot show. The patient's skin and abdominal wall, body habitus, posture and demeanor, breathing pattern, and response to being palpated are adjuncts to the history. The physical examination of the abdomen is an abstract art based on empiricism and tradition, and although not evidence-based for the most part, yet it is still an integral part of the clinical evaluation. The railroad admonition of ''Stop, Look, Listen'' is a useful guide to the sequence of examination.[1] Nowadays, inspection is recommended to precede auscultation

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with the device invented by René-Théophile-Hyacinthe Laennec.[2] (Some pedants consider that Laennec's *stethoscope* was misnamed because it does not facilitate *viewing*,[3] but Greek linguaphiles credit the suffix *scope* to mean any form of examination,[4] not restricted to visualization.) Listening is succeeded by percussion, a technique promoted by Josef Leopold Auenbrugger,[5] and last comes palpation that in bygone years preceded auscultation.

INSPECTION

Much can be learnt from no-touch inspection with a keen eye. Weight loss that the patient may not have noticed or even (self-)denied may be obvious from a small girth, scaphoid shape, and loose skin. Abdominal distension may be caused by central obesity, ascites, enlargement of intra-abdominal organs, gas, constipation, malignancy, and intra-abdominal stage pregnancy, corresponding approximately to the well-worn mnemonic of the six Fs, namely, Fat, Fluid, Flatus, Feces, Fibroids, and Fetus. Striae that corroborate sometime distension are caused by stretching that ruptures the reticular dermis, for which the red/blue or white color can help date the duration and timing. Complementary findings abound elsewhere in the body.[6] Bulging of the flanks usually indicates ascites, which tends to shift with change of posture, whereas other causes of abdominal distension often protrude forward. Clues to the diagnosis may be scars of previous abdominal operations (especially if these are pigmented), localized bulges of hernias, Auenbrugger sign of epigastric bulging in cases of extensive pericardial effusion, and the visible peristalsis of small-bowel obstruction that may be attended by audible borborygmi. The movement of the abdominal wall with respiration, especially if splinted or limited by pain, can give a clue to the nature of intra-abdominal disease.

The presence and distribution of dilated abdominal wall veins should be sought and, later, the direction of their blood flow tested. Fine upper abdominal wall vessels with cephalad flow (Fig. 1A) are paraumbilical veins that are typically seen in cirrhosis and other causes of portal hypertension. Tortuous veins radiating upward and downward from the umbilicus, with respective cephalad and caudad flow, may be the striking but quite uncommon caput Medusæ (Fig. 2A) that stems from hepatofugal blood flow—arguably within a recanalized umbilical vein

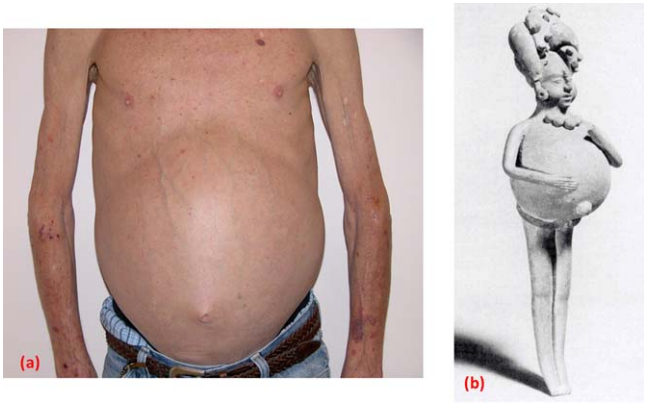

FIG 1 (A) Abdominal distension caused by ascites, showing an everted umbilicus and fine dilated superficial abdominal wall paraumbilical veins in which cephalad flow can be demonstrated by expelling blood between two fingers and observing the direction of return. (B) Figurine from the Mayan burial site on the Island of Jaina (off the Yucatán Peninsula) depicting a man with massive ascites and eversion of the umbilicus. The Mayans of the classic period (300-900 CE) were familiar with the physical signs of massive ascites. Reproduced with permission from *Annals of Internal Medicine*.[23] Copyright 1994, Annual College of Physicians.

but more likely in new paraumbilical veins, in the falciform ligament—that is associated with obstruction or hypertension of the portal vein. Varicose abdominal wall veins with cephalad flow traversing the costal margin, occur in inferior cava obstruction (Fig. 2B), and are comparable to

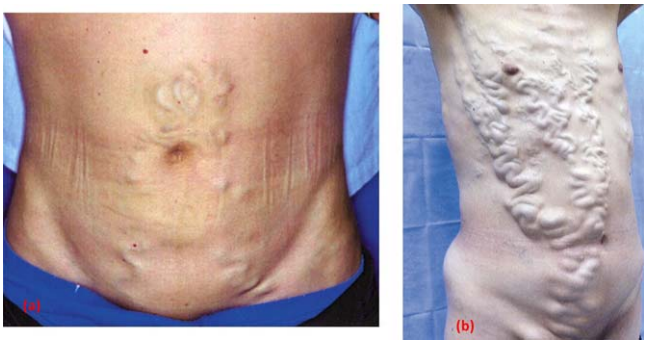

FIG 2 (A) A caput Medusæ of mildly tortuous abdominal wall veins containing hepatofugal blood and radiating from the umbilicus, in a patient with cirrhosis and portal hypertension. The caput Medusæ results from backflow from the left portal vein through paraumbilical veins in the falciform ligament, to periumbilical systemic veins in the abdominal wall. Reproduced with permission from *New England Journal of Medicine*.[24] Copyright 2005, Massachusetts Medical Society. (B) Abdominal wall varices caused by thrombosis of the suprahepatic and posthepatic portions of the inferior vena cava, in a patient with thrombosis of the hepatic veins (Budd-Chiari syndrome). Reproduced with permission from *New England Journal of Medicine*.[25] Copyright 2014, Massachusetts Medical Society.

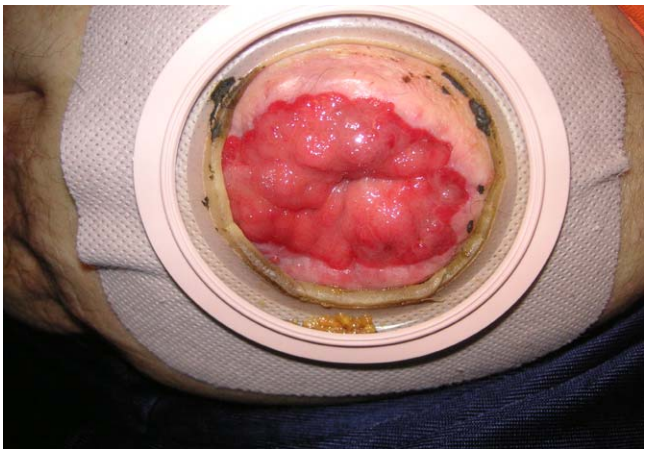

FIG 3 Peristomal varices in a patient with an ileostomy for inflammatory bowel disease and cirrhosis from primary sclerosing cholangitis. Submucosal varices are visible around the entire circumference of the stoma.

similar superficial varices with caudad flow that are seen with thrombosis of the superior vena cava. Portosystemic shunts in portal hypertension are typically concealed in the lumen of the gut, especially in the esophagus and stomach, but such varices may also be visible on the abdominal wall when the intestinal mucosa is exteriorized as an ileostomy or colostomy (Fig. 3).

Skin eruptions may occur on the abdomen and require dermatological diagnosis. The distribution of pox lesions can distinguish between the central location of variola and peripheral distribution of varicella, whereas the location of zoster is dermatomal. Spider nevi are uncommon on the abdomen, usually being found on the upper chest, back, face, and arms, but discrete nonblanching red macules or papules that consist of proliferating capillaries and postcapillary venules, known as Campbell De Morgan spots (Fig. 4), commonly occur anywhere on the abdomen and are age related. These cherry angiomata, once thought to indicate intra-abdominal malignancy, are of no clinical significance.

The umbilicus is a rich source of signs. Psoriatic plaques have a predilection for the navel. Most common is the everted umbilicus (Fig. 1A,B), which occurs when raised intra-abdominal pressure and massive ascites push against an umbilical hernia. The term *portal hypertension* was coined in 1906 by Gilbert and Villaret, who punctured the abdomen in patients with cirrhotic ascites and found elevated pressure. Umbilical hernias can become incarcerated and strangulated. Redness of an umbilical hernia can foretell rupture and the massive leakage of ascites of the emergency so-called Flood syndrome.[7] Discoloration of the navel, commonly but not invariably blue and referred to as Cullen sign (which was actually first described by Hofstätter), is seen in intra-abdominal bleeding from ruptured ectopic pregnancy, acute pancreatitis, and any condition in which there is pigmented peritoneal fluid, and also in ectopic endometriosis. Comparable skin ecchymoses that are paraumbilical are located at points at which vessels perforate the rectus sheath (Fig. 5), whereas flank discoloration, the Grey Turner sign, occurs in acute pancreatitis; ecchymoses from retroperitoneal hemorrhage emerge on the back, an often neglected site for inspection. Intra-abdominal malignancy can metastasize to the umbilicus, where the lesion is known as Sister Mary Joseph (Dempsey) nodule, after the Catholic nun and nurse at St. Mary's Hospital, Rochester MN, now Mayo Clinic, who drew William James Mayo's attention to this phenomenon. Limited space in this review does not allow for the catalog of

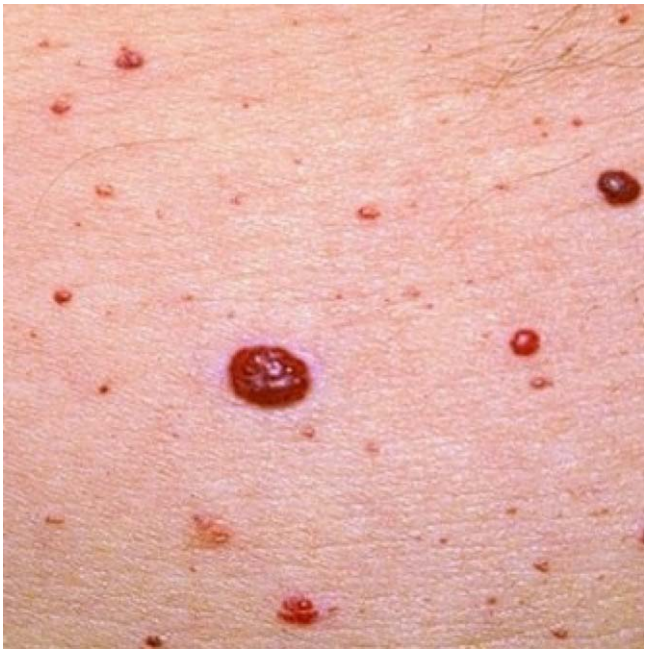

FIG 4 Cherry-red angiomata, also known as Campbell de Morgan spots, which are macules or papules composed of proliferating capillaries and postcapillary venules. These bright red lesions, which can fade to dark brown in time, increase in prevalence with age. They are entirely benign and are only of cosmetic significance. Adapted with permission from Dermis Health.[26] Copyright 2006, Dermis Health.

FIG 5 A variant of Cullen sign, consisting of two paraumbilical ecchymoses, symmetrically located over points at which vessels often perforate the anterior rectus sheath, and another, fainter ecchymosis in the umbilicus Itself. Reproduced with permission from *New England Journal of Medicine*.[27] Copyright 1949, Massachusetts Medical Society.

dermatological clues to abdominal diagnoses[8] that the astute clinician should know.

AUSCULTATION

Auscultation, which is recommended to precede palpation so as not to stimulate or depress resting bowel activity, is accomplished by placing the diaphragm of the stethoscope lightly in close contact with the abdominal wall. Parenthetically, the subterfuge of pressing the stethoscope firmly while pretending to listen may be used surreptitiously to test whether the unsuspecting, distracted patient truly has abdominal tenderness.

Waves of normal gastric and small-bowel peristalsis occur many times a minute and normal bowel sounds are as frequent, but opinions that are based on habit, personal preference, and anecdote (rather than strict evidence) vary as to how long to listen.[9] At a minimum, a minute or two should be invested, but some compulsive clinicians recommend devoting 5 to 7 minutes and even stimulating peristalsis by percussion and/or palpation, before declaring that the abdomen is silent. Auscultation in all four quadrants is traditional, too, but may be excessive because bowel sounds are readily transmitted throughout the abdomen. It is uncertain whether the precise site at which abnormal bowel sounds are heard is anatomically pathologically meaningful. If an abnormal sound or silence (Lockwood sign) is reproducibly highly localized, then perhaps structural correlation should be sought with computed tomography or magnetic resonance imaging. Finally, the diagnostic importance of the frequency, duration, volume, and quality of bowel sounds is questionable and has been dismissed by sceptics. However, marked diminution and especially an absence of bowel sounds seems to be a reliable finding—admittedly dependent to some extent on the patience of the observer and the patient, and ambient noise pollution—indicative principally of bowel obstruction, intestinal ischemia, paralytic ileus, or peritonitis. Potential causes of extreme hyperactivity include anxiety and other excess catecholamine states, gastroenteritis, laxative use, inflammatory bowel disease, gastrointestinal bleeding, and small-bowel obstruction before gut paralysis supervenes. Partial small-bowel obstruction is classically typified by high-pitched hollow tinkling that is reminiscent of the sound of light rain falling on a tin roof.

Other audible signs are bruits (i.e., vascular murmurs), best heard with the bell of the stethoscope, that result from turbulence caused by stenoses or aneurysmal dilatation in high-velocity vessels (i.e., arteries) or in extensive aberrant vasculature, such as the neovascularization of cancers such as hepatocellular carcinoma. Bruits may be heard anywhere in the abdomen, and auscultation should include the flanks and the back, where renal artery murmurs may be heard best. Innocent bruits are prevalent, however, especially in younger individuals, but systolic-diastolic murmurs have high specificity and are worthy of further investigation,[10-13] as is the left upper quadrant systolic rush of a splenic arteriovenous fistula. Low-pitched continuous venous hums that vary with respiration may emanate from the portal venous system as portal hypertensive blood enters the low-pressure systemic venous circulation, via portosystemic shunts. The legendary but rare Cruveilhier–Baumgarten bruit or hum heard continuously at the umbilicus (which is often the site of a caput Medusæ) or the xiphisternum, reflects high-flow to low-pressure systemic veins in the abdominal wall via a patent umbilical vein (or more accurately in paraumbilical veins) in the falciform ligament. In cirrhosis this is Cruveilhier–Baumgarten syndrome, whereas in non-cirrhotic portal hypertension it is Cruveilhier–Baumgarten disease that is classically but not invariably associated with portal vein hypoplasia and liver atrophy. Finally, a friction

rub may be heard with respiration if there is splenic infarction or hepatic metastases and occasionally with peritonitis, as rough peritoneal surfaces slide over each other.[14] With friction rubs and murmurs, the examiner must avoid being misled by noises transmitted from elsewhere, such as the heart and the pleura.

Abdominal auscultation has also been criticized as not being evidence-based,[9] but its practice should continue until it is shown conclusively to owe more to tradition and nostalgia than to clinical science.

PERCUSSION

Legend has it that Auenbrugger's technique of percussive diagnosis that he conceived in 1754 had its origins in his boyhood in Graz (Austria), when he watched his father knock casks in the cellar of his inn to assess how much wine was in them. Yet, Avicenna, Hippocrates, and Galen may have used percussion a millennium or two earlier, and veterinarians have long tapped the heads of cattle to diagnose cysticerci. The 1761 publication[5] in Latin of Auenbrugger's *Inventum novum* (new discovery) had a limited impact until popularized worldwide in 1808 in a translation by Napoleon's favorite physician, Jean-Nicolas Corvisart des Marest. *Direct* percussion of the chest or abdomen, for which one taps with one or two fingers, is upgraded to *indirect* percussion,[15] by applying *a pleximeter*, usually the middle finger of the left hand, firmly to the chest/abdominal wall to displace any intervening air and to absorb the energy when the middle phalanx is struck with *the percussor or plexor*, usually the middle finger of the right hand that is flexed to form a right angle between the proximal and middle phalanges. It is instructive to describe this time-honored technique in detail and to emphasize that effective interpretable percussion comes only with practice. Expert percussion involves a series of sudden flicking strokes arising smoothly at the supple flexed wrist, so that the distal pad of the plexor hits the middle phalanx of the pleximeter smoothly and sharply, and withdraws immediately to prevent damping of the percussion notes. From their sound and tactile perception, the abdominal notes can be categorized as resonant or tympanic due to air or gas; dull due to muscle, soft tissue, or an organ; or stony dull due to fluid. Malposition of the pleximeter and/or jerky, stiff, or irregular execution of the strikes leads to erroneous findings on percussion.

Abdominal percussion is used most frequently to determine whether free peritoneal fluid, namely, ascites, is present, especially if there is abdominal distension.[16,17] Ascites is generally undetectable on physical examination until the volume is approximately 2 L or more, depending on the patient's body habitus. The corollary is that ascites can be present even if undetectable clinically, but can readily be seen on cross-sectional imaging. Before ascites completely fills the abdominal cavity, it gravitates to the flanks and the pelvis when the patient lies supine, causing bulging and accounting for flank dullness, both of which are highly sensitive findings that must then be distinguished from the dullness of the flank muscles, fat, and soft tissues. Depending on the volume of ascites, there is an inverse degree of central abdominal resonance from floating bowel, giving a U-shaped distribution of dullness. Marked abdominal distension without any dullness, especially when there is hyperresonance or tympany, and abnormal bowel sounds—absent, tinkling, or hypoactive—imply gaseous intestinal distension or even free intraperitoneal air. Resonance in the subcostal region of the left upper quadrant is usually the gastric air bubble, which can increase in size/extent with distension because of gastric outlet obstruction, gastric ileus, or gastroparesis.

The key maneuver in identifying ascites that is neither massive nor minimal is to demonstrate "shifting dullness"[16,17] by repeating percussion after rolling the patient to one side and finding that there is now resonance in the flank that is uppermost and simultaneously increased dullness in the dependent side. Confirmation should be obtained by repeating the maneuver on the other side. The test may also be positive in patients with diarrhea and even with obesity, because fat is liquid at body temperature, even though it is confined in adipocytes. The practice of eliciting a fluid wave is to be eschewed because it is insensitive, and although positive results are allegedly specific,[16,17] these are usually obtained when ascites is voluminous enough to be obvious visually and shifting dullness is easily elicited. To demonstrate a fluid wave, the examiner requires a third hand to immobilize the abdominal wall, because the technique of sharply tapping one flank and feeling the wave hit the opposite flank with the second hand is rarely performed well. Eliciting the so-called puddle sign of ascites should also be completely avoided to spare the patient the futile indignity and discomfort of being examined while crouching on all fours.

Percussion is used to map the size and location of the liver, the spleen, and masses, including those arising from the pelvis, capitalizing on the contrast between the dullness of the organ and resonance caused by air/gas in adjacent structures, such as the lungs and the intestines. Resonance within an otherwise solid organ or mass may indicate the presence of gas in a bowel-based lesion or rarely in an abscess. To measure the coronal span of the liver,[14,18,19] its upper *and* lower borders should be delineated by percussion of the right chest and abdomen in the midclavicular line (where the liver span is normally maximal), with breath-holding and with breathing, as movement with respiration helps to confirm the dullness as hepatic and show whether the diaphragm can contract. Percussion of liver dullness in the midsternal line, where the finding that the span may be the same or greater than in the midclavicular line (Fig. 6), detects left lobe enlargement that is typical of cirrhosis,[14] and which also may be felt as a firm mass in the epigastrium. Palpation may be necessary to define the lower border of the liver (see later), whereas some advocate the optimistic practice of listening over the liver while scratching the skin of the right side of the abdomen progressively upward. Hearing the scratching is presumed to signal that the lower edge of the liver has been crossed.

The spleen, which is a posterior organ lying along the 9th to 11th ribs, enlarges anteriorly where it is detected in the lower left chest by dullness instead of resonance, above the gastric air bubble, in the lowest anterior intercostal space,[14] or more strictly by laterally displacing rightward Ludwig Traube semilunar space (bounded by the left sixth rib superiorly, the left midaxillary line laterally, and the left costal margin inferiorly). Similar dullness may be caused by a pleural effusion.

Percussion can cause pain that may be generalized when there is peritonitis, or more or less localized to sites of underlying organ injury and inflammation, such as the stretched capsule of the congested/engorged liver, the inflamed gallbladder of cholecystitis,[20,21] and characteristically to the lower right thorax in cases of acute cholangitis; the so-called punch sign is misnamed, because punching a patient is discouraged.

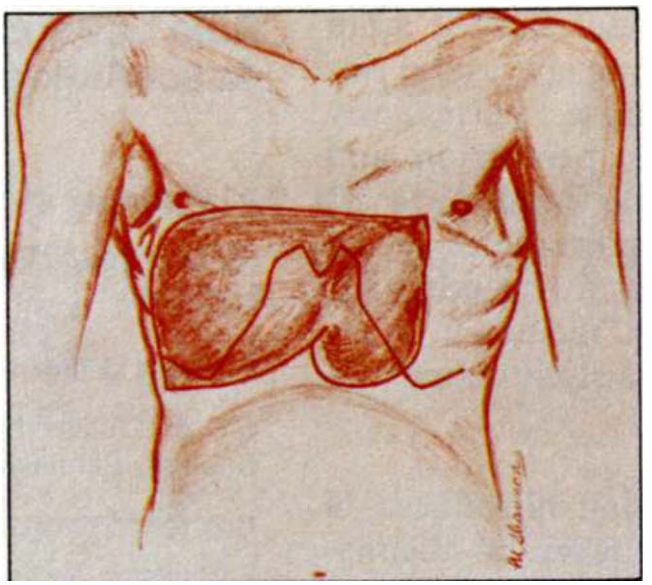

FIG 6 Outline of cirrhotic liver with left lobe enlargement. This gives a ''squaring-off'' effect on percussion, in which the liver coronal span in the midsternal line may be the same or greater than in the midclavicular line. The enlarged left lobe is frequently palpable as a firm to hard epigastric mass, which moves with respiration. Reproduced with permission from *Postgraduate Medicine*.[14] Copyright 1977.

PALPATION

Palpation should be approached cautiously and gently, especially in the patient complaining of abdominal pain, and care must be taken to avoid the touch of cold hands. Examination of the abdomen should begin with light ''scouting'' palpation in all four quadrants, looking for and noting masses, guarding—voluntary or involuntary—and tenderness both with application of pressure and its release, that is, rebound tenderness that reflects peritoneal inflammation. In acute appendicitis both tenderness and rebound tenderness may be referred from the left to the right lower quadrant (Rovsing sign). The abdominal wall is scrutinized for hernias, nodularity, masses, hyperesthesia and anesthesia, point tenderness,[22] crepitus, and reflexes. Direction of flow in superficial veins is determined by gently expelling the blood between two fingers and observing its return. Palpation while the patient flexes the abdominal muscles can help distinguish local from deep tenderness, and abdominal wall masses from those arising from intra-abdominal structures. In cases of obscure abdominal pain, it is often fruitful to perform a thorough spinal examination, including palpation, percussion, and all movements, looking for a cause of pain referred to the abdomen, which may have an orthopedic or neurological explanation.

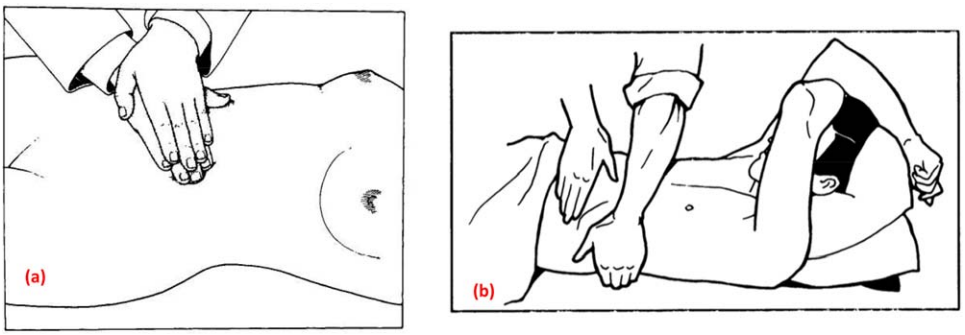

FIG 7 (A) Two-handed technique for deep abdominal palpation. Reproduced with permission from *Clinical Methods: The History, Physical, and Laboratory Examinations*. 3rd ed.[28] Copyright 1990, Butterworth Publishers. (B) Bimanual technique of palpation for the spleen. One hand placed beneath the back on the left pulls the lower thorax forward, thereby bringing the spleen (which lies posteriorly along the seventh to ninth ribs) toward the palpating hand. Reproduced with permission from *Western Journal of Medicine*.[29] Copyright 1991, British Journal of Medicine group.

Each of the four quadrants is then palpated more deeply, as tenderness permits, starting remotely from a less painful region; raising the knees with a pillow can enhance relaxation. Some experienced clinicians recommend using one hand to apply pressure to the deeply palpating other hand (Fig. 7A), which is a personal choice that looks very professional. An alternative is to palpate with the medial (index finger) edge of the *blade* of the hand, avoiding firm pressure with the fingertips unless necessary eventually for deep abdominal palpation. The lower border of the liver is identified by palpating progressively upward from the right lower quadrant toward the right costal margin, from which the enlarging organ emerges; its uppermost surface/margin cannot be reached. The liver moves downwards with inspiration, its consistency, any irregularity of its edge, tenderness, and pulsatility. Pressing on the liver to elicit a so-called hepatojugular reflux as proof of right-heart failure is a bad idea because the congested liver will be tender; instead, pressing anywhere in the abdomen raises intra-abdominal pressure and increases venous return to the heart. If right subcostal tenderness limits or arrests deep respiration, this is termed a positive Murphy sign of acute cholecystitis,[20,21] after the flamboyant surgeon with the red parted beard who described it. A palpable structure below the right costal margin may simply be the normal variant tongue-like inferior projection of the right or Riedel lobe of the liver. A globular subcostal mass may be gallbladder cancer, or painless gallbladder distension in the patient with jaundice caused by malignant biliary obstruction that is located below the insertion of the cystic duct (Courvoisier sign). On rare occasions, the gallbladder is palpable in acute cholecystitis, which is known as Cope sign. However, no findings of acute cholecystitis are sufficiently reliable to forgo the need for imaging.[20,21]

Palpation for an enlarged spleen begins with the hand in the right lower quadrant, moving diagonally upward to the left costal margin, along the trajectory of splenic enlargement, until the so-called tip of the spleen is felt. The other hand pulls the posterior thorax forward, to present the posterior-lying spleen to the palpating hand (Fig. 7B); again respiration is used to enhance accessibility and identification. Feeling a splenic notch is an accomplishment that few examiners are likely to achieve. Kidneys are best examined bimanually, also using the posterior hand to bring these posterior organs forward. Unlike the liver and spleen, it is theoretically possible to palpate the upper and lower poles of the kidneys. The size and surface nodularity of kidneys are noted. Any other abdominal mass that is felt should be mapped and its size, surface, consistency, tenderness, mobility, pulsatility, and auscultative findings characterized; visible peristalsis is noted if present.

Abdominal palpation is insensitive for the detection of all but the largest aortic aneurysms, and there are many false positives.[12,13] A tubular mass that the fingers can roll over may be felt anywhere in the distribution of the colon, caused by stool or more sinister thickening; a cecal or appendicular mass is usually globular.

CONCLUSION

Examination of the abdomen is an art laced with science. Sceptics question the diagnostic reliability of the physical signs of abdominal disease. The paucity of bona

fide evidence for the strength of physical diagnosis must be conceded, to some extent. Yet, since the revolutionary introduction of physical examination in the 19th century, seasoned clinicians have found the sequence of *inspection*, *auscultation*, *percussion*, and *palpation* to be useful and still to provide guidance for the further investigation of abdominal disease using sophisticated imaging and other techniques. Moreover, certain aspects of bedside examination cannot be superseded by imaging, such as skin abnormalities, patient demeanor in response to overt and surreptitious palpation, the collateral evidence of referred pain, and many other clues.

CORRESPONDENCE

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