

monary area. These points being found they should be connected by a slightly curved line, which will include and indicate with substantial accuracy those other points, lying between the two extremities of the line, which are not distinctly demonstrable by percussion. The *anterior* border of the spleen, covered, like the posterior border, by lung in its upper third, comes in its lower two-thirds into somewhat close proximity to the greater curvature of the stomach, while its lowest third is in immediate relation with the splenic flexure of the colon. If the stomach be dilated, as after a hearty meal, the tympanitic or ringing metallic sound which it then gives modifies the dulness not merely of the anterior part but of nearly the whole of the splenic area. The colon, also, when distended with gas, encroaches on the splenic dulness.

The changes in form and dimensions which the splenic dulness undergoes may be caused by dislocation of the spleen, by apparent and by actual enlargement of the splenic area.

Very deep respiration is attended by a slight *dislocation* of the spleen. In inspiration the organ sinks somewhat in the abdominal cavity, but the space which it renders dull to percussion becomes smaller, as its upper end is more fully shut in by pulmonary tissue. In tranquil inspiration, however, no downward displacement of the lower limit of the spleen is noticeable. The spleen is pushed still further from its normal situation, and its area of dulness to a similar extent reduced or even caused to disappear, by left pleuritic effusion, pneumothorax, and pulmonary emphysema. In cases of pleurisy in which the fluid is so abundant as to occupy the front as well as the back part of the pleural sac, the splenic dulness and that due to the presence of the effusion cannot be defined from each other; if the exudation be unusually copious, and the diaphragm be depressed, the spleen also is displaced and protrudes from under the costal arch.—In left pneumothorax the splenic dulness may vanish completely; the spleen, however, is commonly driven downwards by the weight of the pleural effusion which is always poured out soon after the air has gained access to the pleura.—In like manner the pressure of an emphysematous lung causes the spleen to sink to a lower point in the abdomen. In a case of this kind the splenic dulness is always greatly diminished in size, as the margin of the lung creeps downward over the upper

part of the spleen to a considerable distance, whilst the actual descent of the organ, due to depression of the diaphragm, is comparatively trifling.—If the spleen be dislocated upwards, as from ascites, its area of dulness is not traceable on the surface; if the displacement be the result of an extreme degree of meteorism, the splenic dulness is invaded and lessened in size, as on the one hand a larger portion of the spleen is covered by lung, and on the other the dull sound it renders to percussion is overborne by the loud and clear intestinal note.—If the dislocation be complete, if the spleen have, in other words, become *movable*, percussion-dulness is entirely wanting in the region corresponding to the normal anatomical situation of the organ.

Apparent enlargement of the splenic dulness is produced when the hollow or air-containing organs in its immediate vicinity are from any cause transformed into solid, airless structures. The dulness of these solid organs then becomes continuous with that of the spleen. This is what takes place in cases of effusion confined to the posterior lower part of the pleural cavity, consolidation of the lower lobe of the left lung, engorgement of the colon with faecal masses, tumours of the liver of such dimensions that they reach over to the spleen, &c. Careful examination, however, will suffice to establish the diagnosis of apparent enlargement of the splenic dulness from actual increase in the volume of the spleen itself, the former condition being characterised by an irregularity of form which is strikingly different from its normal oval or rhomboidal outline, and by the total absence of the usual shifting of the area of dulness on altering the attitude of the patient, as on changing from the upright to the recumbent posture on the right side. The other methods of physical examination also at once suggest the merely apparent character of the augmentation of the splenic dulness and indicate its special causes.

Actual enlargement of the splenic dulness is the result of enlargement of the spleen itself. The non-resonant area is normal as regards shape, but is increased in size in all directions; the lines therefore which are represented above as bounding the normal splenic dulness are set more widely apart, on account of the lengthening of the vertical and transverse diameters of the splenic area. The extension of the dulness takes place most commonly downwards and backwards, when the swelling of the

spleen is moderate in degree; when this is still greater the organ passes beyond its normal limits anteriorly as well as in the other directions, and when the tumour is of unusual dimensions it pushes the diaphragm upwards* before it into the thoracic cavity, and percussion then shows that the upper boundary of the spleen occupies a much higher position than normally.

As enlargement of the spleen is invariably attended by increase in the thickness (the antero-posterior diameter) of the organ, the *intensity* of the dulness is also always much greater than over the normal spleen; the percussion-sound of a large splenic tumour is as absolutely dull as that heard over the liver, while the sense of resistance experienced in the percussing finger is augmented to a very unusual degree. The larger the spleen becomes in all its diameters the more easily definable is it by percussion, the influence of the sounds given by the parts in the vicinity being eventually completely neutralised as the hypertrophy of the organ goes on.

If the spleen forms a distinct tumour, protruding from under the arch of the ribs, it must, except in some rare cases of dislocation (movable or wandering spleen), be regarded as enlarged. When it comes down in this way into the abdomen examination by percussion may almost be said to be superfluous, as much clearer and more definite information may then be obtained by palpation. The signs which a splenic tumour gives to palpation are so distinctive as very seldom to leave any doubt as to the real nature of the swelling under consideration (see p. 328). As a confirmatory test, however, percussion is here of some importance, as it shows that the line of dulness is unbroken between the normal splenic area in the lower thoracic region and the non-resonant space corresponding to the tumour.

Tumours of the spleen may be unrecognisable by percussion, or recognisable only with difficulty, if there be much meteorism or ascites present. If the swelling reach to a point considerably below the level of the ribs, however, it may always be determined, if not by percussion, at least by palpation, especially if pressure be made with the hand firmly and suddenly, in such a way as to displace the fluid for a moment.

* In one case which I observed, in which the whole abdomen was filled by an enormous splenic tumour, the apex of the heart was found beating at the level of the fourth rib; immediately below this point also the absolute splenic dulness began.

PERCUSSION OF THE STOMACH.

A small portion of the anterior surface of the stomach, and the larger part of its great curvature, are in direct contact with the abdominal parietes anteriorly; the rest of the organ is covered over, partly by the left lobe of the liver and partly by the left lung. This portion of the stomach, that which in front touches the wall of the abdomen, is bounded towards the right by the left lobe of the liver, and superiorly by the lower border of the left lung, which turns backwards behind the sixth and seventh ribs, to the outside of the apex of the heart; the lower border of the stomach, its larger curvature, crosses the epigastrium from the left lobe of the liver to the left hypochondrium in a curved line situated nearly midway between the point of the xiphoid process and the umbilicus, inclines upwards and outwards opposite the free end of the tenth rib, and at the level of the sixth rib, in the anterior axillary line, meets the upper boundary of the organ. These are the limits of the stomach when it is in a state of only moderate distension.

It follows from what has just been stated that it is never possible to delimit the stomach in its whole circumference by means of percussion, but only so much of it as is not overlapped by other organs and is in immediate relation with the anterior abdominal wall. In examining the stomach the patient should be placed on his back, this being the most convenient position for percussion in this region. The upper limit of the stomach should first be found, the line along which the clear pulmonary note gives place to one which is tympanitic in quality; the boundary of the gastric area towards the right may then be determined by following the edge of the hepatic dulness till it ends in the lower margin of the cardiac dulness; the delimitation of the superficial gastric area is completed by tracing the course of its lower border, which coincides with that of the greater curvature of the stomach (see above). The close proximity of the transverse colon, however, often proves a serious obstacle to the proper carrying-out of this proceeding, as the percussion-sounds of the great intestine and the stomach are sometimes exactly alike both in intensity and pitch, when all that can be accomplished is usually merely to fix certain points in the line of the

lower boundary. In other cases, however, when the sound of the colon is higher in pitch than that of the stomach, the course of the larger curvature may be made out with much greater precision. The percussion-sound in the gastric area just described is generally loud, clear, tympanitic, and of *low pitch*.

The gastric percussion-sound undergoes many modifications both in quality and in the extent of surface over which it is audible, according as the stomach is empty, partly filled, or completely and fully distended by its contents.

When the stomach is empty a deep and clear tympanitic note is heard over its whole extent; but if it be so fully occupied by fluid and solid matters that but little space is left in it for air, the region of tympanicity is diminished in size, and at the dependent parts of the great curvature the sound is often muffled, when it becomes easy to distinguish it from the tympanitic sound of the transverse colon, provided also that this part of the intestinal canal is not in a similarly overloaded condition. If the stomach contain only a moderate quantity of solid matters there is no muffling of the percussion-sound; if there be also a considerable volume of air present the sound may even be tolerably clear, so much so as to become indistinguishable from that of the colon.—When the stomach is overcharged with food the tympanitic gastric area is also considerably altered in extent, the above-described lower boundary-line, representing the larger curvature, being shifted further downwards, to a greater distance from the upper limit of the tympanicity proper to the stomach (the sixth rib); the somewhat crescentic gastric area is thus increased in diameter, it includes the whole left hypochondrium, overspreads and masks the anterior part of the splenic dulness and to some degree also that part of the hepatic dulness which marks the left lobe of the liver.—If the stomach be widely dilated by gas, so that its walls are in a state of considerable tension, a *metallic* quality is noticeable in the percussion-note over a greater or less area, when the ear is held close to the spot percussed or when instead of the hammer a small metallic rod is used (see p. 106). Were it possible to elicit this metallic sound over the whole of the gastric area, we should have in this system of percussing with a small rod of metal a means of fixing the boundaries of the stomach with almost absolute exactness. This method of examination has been elaborated particularly by

Leichtenstern, but the results it yields are far from being perfectly satisfactory, as the metallic sound so produced is not only not heard over the *whole* of the region corresponding to the stomach, but is also sometimes audible over the transverse colon when it is inflated with gas.—There is still another method, however, described by Frerichs,* whereby the outline of the stomach may be traced on the surface with somewhat greater precision. To the patient to be examined is administered a quantity of tartaric acid, followed up by a like quantity of bicarbonate of soda dissolved in water; effervescence takes place freely within the stomach, which is soon distended by the carbonic acid gas disengaged. When in this condition the stomach, which often forms a visibly prominent swelling in the epigastric region, gives a deep, tympanitic, and metallic percussion-sound, frequently of a strikingly different character from that rendered by the transverse colon.—Another method sometimes adopted to distinguish stomach from bowel by percussion, is to fill the former with fluid, when the sound obtained along its lower border, the patient being in the upright position, will be found to be dull.

The tympanitic gastric area which is here represented as associated with a medium state of dilatation of the stomach, may appear to be dislocated, increased, or decreased in size.

The stomach is *dislocated* downwards in those conditions in which the diaphragm is depressed,—copious pleuritic effusion, pulmonary emphysema; it is displaced upwards when the diaphragm is caused to rise to a higher level in the thorax, as by ascites, or large abdominal tumours.

The gastric resonant area is *diminished* by tumours of the liver and spleen, when these are sufficiently large to encroach upon the stomach to any extent.

Enlargement of the space which the stomach renders tympanitic to percussion occurs in cases of pathological dilatation of the organ. It is one of the signs frequently observed in gastric catarrh of long duration, and more especially in connection with stricture of the pylorus; in these circumstances the stomach is dilated along its greater curvature, its lower boundary sinks

* In like manner Schreiber has proposed to pass into the stomach an cesophageal tube, to which is attached a small india-rubber balloon; this balloon, when it reaches the stomach, is inflated by blowing through the tube, and the organ is in this way distended with air.

sometimes even as low as the umbilicus, while to the right it may extend far over the middle line, and to the left may pass beyond the axillary line, so that the whole upper, and occasionally also the middle portion of the abdominal cavity is occupied by the dilated organ. Throughout the whole of this region the percussion-sound is tympanitic, and at some parts may possibly be of a ringing metallic character, if the stomach contain chiefly air and only a relatively small proportion of fluid. If the stomach-contents consist mainly of fluid, and if the abdominal wall be soft and lax (as it generally is, these cases being usually marked by excessive emaciation), the gastric percussion-sound undergoes considerable modification on altering the position of the patient, and in this way the delimitation of the part may be greatly facilitated; thus, in the upright position the fluid gravitates to the lowest level within the stomach, and the sound along the greater curvature becomes much less resonant and more readily distinguishable from the clear tympanitic note of the colon. The lateral limits of the stomach may be determined in like manner, by turning the patient first to the right and then to the left side; the fluid, as before, seeks the lowest level, when the previously clear tympanitic percussion-sound at the points to which it sinks becomes feebler and duller.

The signs which the dilated stomach presents to inspection and palpation (see pp. 318 and 332) are often of the greatest value as aids to percussion in determining the limits of the affected organ; frequently, indeed, these are the only indications which can be trusted to in the diagnosis of the condition under discussion. In several cases of enormous dilatation which have come under my own notice the greater curvature of the stomach was recognisable as a well-marked, slightly prominent line or elevation which crossed the abdomen below the umbilicus, and which, on being smartly rubbed with the hand, showed peristaltic movements in relief with surprising distinctness. In two of these cases, in order to define the lower gastric boundary from the colon by means of percussion, I emptied the stomach with the stomach-pump and injected 4—5 kilogrammes of water; then only did the previously tympanitic sound become dull.

PERCUSSION OF THE INTESTINE.

The percussion-sound of the *great and small intestine* is, in health, always tympanitic. The pitch of this tympanitic sound is different at different points on the abdominal surface, and is

subject to constant variation; this alteration in pitch is in general caused by the very variable condition of the bowel with regard to the amount of gaseous and solid matters it contains, and by the consequent variation in the tension of the walls of the intestine. Though a definite statement, therefore, of the points at which the tympanitic percussion-sound will be found to be lower or higher in pitch cannot be made, the general rule may nevertheless be laid down, that over the small intestine the sound is higher in pitch than over the large intestine.

The tympanitic intestinal sound is most exquisitely developed at those points at which the abdominal coverings are not too tense, at which, accordingly, they do not interfere with or muffle the percussion-note. It is thus always more or less diminished in resonance when the patient stands, this being the result chiefly of the tension of the recti muscles; a large accumulation of fat in the subcutaneous tissues has the same effect on the sound.

The raising and lowering of the pitch of the tympanitic intestinal sound so often observed in disease are generally referable to definite pathological causes. If there be an unduly small proportion of gaseous matters present in the intestine the latter is diminished in calibre, (as in ascites, in which the fluid presses on the bowel), and its percussion-sound rises in pitch; thus, in a case of ascites in which the small intestine is compressed into much less than its normal bulk, the sound above the level of the effusion is *acutely* tympanitic.—When, on the other hand, the bowel is tensely inflated with gas, the abdominal percussion-sound becomes deeper in pitch, but not tympanitic; this is observed, physiologically, after a heavy meal; pathologically it occurs in peritonitis, in typhoid fever (from paralysis of the muscular coats of the bowel), and in cases of stricture of the intestine, from the obstruction set up to the onward passage of the intestinal contents. The sound is lowered in pitch, because a larger body of air is thrown into vibration, but it is not rendered tympanitic, as the *wall* of the intestine as well as the *air* it surrounds is caused to vibrate (see p. 91).

If a portion of the bowel, situated above a stricture, be widely distended with gas, a ringing *metallic percussion-sound* is heard over it, while below the point of constriction the whole intestinal tube is reduced in lumen and therefore gives no such sound to percussion.

The intensity of the tympanitic note varies very much at different points on the surface of the abdomen, these changes being dependent on the amount and nature of the intestinal contents. The more solid the matters lying in the bowel, and the less the proportion of gas mixed up with them, the less the intensity of the tympanitic sound. Thus, at those parts beneath which lies the intestine loaded with large masses of faecal material, the sound acquires the dull tympanitic character; in the left iliac region particularly, when the descending colon is filled with retained excreta, the percussion-note is less clear than at the corresponding point on the right side. Nevertheless the sound is never absolutely dull, even when the accumulation becomes enormous in amount.*

If, on the other hand, the intestine contain little solid matter but a large quantity of gas, the percussion-sound becomes very loud, but, at the same time, loses its tympanitic character if the intestinal walls are so tense as to be capable of entering into simultaneous vibration.

Accumulation of gas in the peritoneal sac, most commonly the result of perforation of the intestine, sometimes also owing to the disengagement of gas from a putrid peritoneal effusion, and in rarer cases caused by the bursting of a pyopneumothorax through the diaphragm, may give rise to the same intumescence of the abdomen as intestinal meteorism.—The percussion-sound in such cases is often in no way different from that of the last-mentioned affection; occasionally, however, it is of a ringing *metallic* quality. Further, if the gas burrow upwards between the anterior surface of the liver and the abdominal parietes, that is, to the highest point within the abdomen when the patient lies on his back, forcible percussion elicits a *clapping* or flapping sound, resembling that obtained over the stomach or bowel after removal from the body, due to the collision of the flaccid and only partially distended walls of these parts when struck with the percussing instrument. In both instances the sound originates in the sudden escape of the layer of air which is compressed by the percussion-stroke.† In cases of this nature,

* Barth records the case of a boy who presented two large intestinal faecal tumours, one of which measured 12 ctm. in diameter, over which the percussion-sound was not absolutely dull, but of dull tympanitic quality. The mass which occupied the bowel was found, at the post mortem examination, to weigh 6 kilogrammes.

† Chomjakoff, on the contrary, explains the clapping sound heard on percussing

also, percussion of the lower and posterior parts of the abdomen usually reveals the presence of fluid effusion, as along with the intestinal gases a quantity of the liquid contents of the bowel escapes into the peritoneal cavity, and this very speedily excites a diffuse peritonitis with exudation, if the orifice in the intestinal wall be not at once closed by adhesive inflammation.

It is hardly possible to confound intestinal meteorism with an accumulation of gas in the peritoneal sac, in view of the violence of the symptoms by which the latter accident is attended,—the signs of perforation and subsequent peritonitis. The principal physical sign on which the diagnosis of the entrance of intestinal gases into the peritoneum is based is the disappearance of the hepatic dulness on both sides of the median line, as the bubbles of gas seldom fail to make their way upwards to the highest part of the cavity (see also the section on auscultation, p. 373).

FLUID EFFUSION IN THE PERITONEUM.

An effusion which does not rise above the pelvic cavity is not discoverable by percussion; as it increases gradually in quantity, however, and extends upwards into the abdomen, it renders dull the percussion-sound over more and more of the lower abdominal region when the patient stands erect. When the whole abdomen is filled with the fluid the sound is at all points dull, but the dulness becomes *absolute* only when the effusion is so abundant as to press heavily on the bowel, the latter being thus to a great extent emptied of air and so compressed as to occupy much less space than normally. Nevertheless, on sinking the pleximeter deeply into the abdominal tissues, and in this way pushing aside a portion of the fluid, the previously dull sound is made somewhat clearer by the accompanying tympanitic intestinal sound. Very frequently the air-filled coils of intestine are floated up on the surface of the fluid, and are therefore detected *above* the area of dulness; in such circumstances the sound will be found to be of clear tympanitic quality on percussing with a gentle stroke, and of the dull tympanitic variety on percussing forcibly and

when bubbles of gas are interposed between the liver and the abdominal coverings as caused by the shock of these parts against each other when subjected to an energetic stroke. The explanation offered above, however, seems to me more natural and more in accord with that which is most generally recognised as satisfactory in the case of the bruit de pot fêlé,—a phenomenon to which the sign under discussion presents a close analogy.