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THE DIAPHRAGM PHENOMENON OR LITTEN SIGN

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LITTEN'S description of the diaphragm phenomenon calls attention to a physical sign, which, because of its invariable presence, is of great value in differentiating between suprarenic and infrarenic pathologic processes, and also in differentiating between pleurisy and pneumonia, and between pneumothorax and emphysema.

The normal diaphragm phenomenon, (as well as its modifications by any pathologic process,) is so apparent on close inspection, and is of such great assistance in clinical diagnosis that we must wonder how so valuable a physical sign could have escaped observation until the recent publication of Litten.¹ The muscular leaflets of the diaphragm have for their points of attachment the central tendon and the lower six ribs on each side at the points of junction between the respective ribs and their cartilages. The central tendon of the diaphragm is firmly united to the pericardium, so that, during the act of respiration, the descent of the central tendon is measured by the mobility of the base of the heart in a downward direction. The excursion is very slight, being not greater than from one to two centimeters. The diaphragm serves to enlarge the thoracic cavity at the expense of the abdominal cavity by converting the curved line of its leaflets into a straight line during the contraction of its muscles. The contraction of the phrenic muscle exerts a positive tension upon the central tendon which is incapable of lateral movement under ordinary circumstances, and upon the anterior ends of the lower six ribs whose excursion varies with the flexibility of the thoracic cage as a whole. The floating ribs are capable of greater excursion than the fixed ribs, because of the want of articulation at the anterior ends. The tension of the contracting diaphragm, on the sixth, seventh, eighth, ninth, tenth, eleventh and twelfth ribs is resisted by the *levator costarum* and inter-

1.—*Deutsche Medicinische Wochenschrift*, 1895

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nal intercostal muscles in ordinary respiration; on forced inspiration, when the external auxiliary muscles are brought into play, the *serratus magnus* offers resistance to the diaphragmatic tension on the sixth, seventh and eighth ribs. There are then several essential reasons why the rotation of the ribs on their vertebral hinges during forced inspiration should be more apparent in some ribs than in others. The importance of this observation will appear later in the discussion.

During expiration the upper surface of the diaphragm is sharply convexed. That portion of the superior surface of the diaphragm bounding the pleural culdesac is in contact with the thoracic wall. When an inspiratory effort is made this portion of the diaphragm, reflected against the thoracic wall is forcibly withdrawn. The thoracic wall and the lung both tend to follow the diaphragm. The elasticity of the lung enables it to follow the diaphragm in its entire excursion, thus filling the enlarged pleural culdesac. Want of elasticity prevents any marked excursion of the chest wall, but the attempt of the chest wall to follow the receding diaphragm in the beginning of inspiration manifests itself in a band of retraction usually about three centimeters wide running along the thoracic wall, following the lower border of the lung and reaching from the parasternal line to the midaxillary line. Almost the entire band of retraction lies below the lower border of the lung, as can be readily shown by percussion. Besides this band of retraction which involves the costal and intercostal spaces to an equal degree, we can often see (in a flexible thorax) the costal spaces retract a little more than the intercostal spaces. This tendency to an equalization of the costal and intercostal spaces throughout the band of retraction is due to the tension exerted on the anterior end of the rib from the insertion of the diaphragm.

If one will observe closely, during the inspiratory movement there can be seen a sharp line like a shadow on the inner side of the chest wall running along the upper border of the retraction-band, which, as inspiration progresses, descends across the entire retraction-band so that as inspiration is completed the retraction-band is, so to speak, entirely erased. This shadow line is the lower border of the lung descending to fill the pleural culdesac. In any subject, and especially one with a thin thorax and good pulmonary excursion, this line can be readily demonstrated by percussion. The descent of the lung is so visible that the pulmonary excursion can be readily located and measured without the aid of percussion.

If we compare the left hypochondrium with the right during respiration we will see the band of retraction and the descending line of the lung as on the right side; but in the left hypochondrium we miss the large shadow of the liver which fills the right hypochondrium and can be plainly seen under the ribs to ascend and descend with respiration.

The diaphragm phenomenon in clinical diagnosis is often of very great service in determining whether an area of dullness in the lower portion of the thorax be due to an infraphrenic or supraphrenic process. We often are required to differentiate between a right-sided empyema and an hepatic abscess in the dome of the liver. In both instances we may have bulging of the thorax, flatness on percussion, absence of vocal fremitus and voice sounds, and in both cases the dullness may begin as high as the fourth rib in the axillary line and in both cases the lower border of the liver may extend downward only as far as the costal border, or slightly below it. Pneumonia with a stopped bronchus may give exactly the same physical signs. In all these instances the diaphragm phenomenon will be modified. In the case of the empyema the pleural culdesac is filled with fluid. The upper surface of the diaphragm is no longer in contact with the hypochondrium; for this reason the band of retraction will not be so broad as on the left side. The descent of the lung will be absent. All that is visible will be a narrow band of retraction at the lower portion of the area of thoracic dullness, due to the tension on the anterior ends of the ribs. In pneumonia as in empyema there will be an area of dullness intervening between the band of retraction and the resonant lung above. The band of retraction, however, is broader, more sharply defined, and slight pulmonary excursion may often be seen. In hepatic abscess at the dome of the liver the diaphragm usually shares in the inflammatory process. Its muscular activity is largely sacrificed. It is no longer able to withstand the retraction of the elastic lung from above and the intra-abdominal pressure from below forcing the enlarged liver upward; as a result the liver ascends in the thorax and there is a larger surface of the diaphragm reflected against the thoracic wall. Physical examination will give flatness on percussion, and absence of palpable and audible vocal fremitus and respiratory sounds may be found from the fourth rib in the axillary line downward. Now, however, when the patient makes a strong inspiratory effort we will see a relatively feeble, but broad line of retraction which begins above where the flatness begins, say at the fourth rib. The diaphragm phenomenon has ascended, which necessarily means that the liver has ascend-

ed. The excursion of the lung is, however, absent. This phenomenon I have plainly seen in two cases of abscess at the dome of the liver which had perforated the diaphragm and lung and whose pus had been expectorated. In both cases, the relation between the diaphragm phenomenon and the area of dullness was of considerable assistance in making a differential diagnosis.

Recently at the City Hospital, a patient was brought in in a semi-comatose condition with profound icterus. The temperature ranged from 98° in the morning with a gradual rise to 104° and 105½° in the evening. There was no sweating. The spleen was palpable at the costal border. The lower border of the liver came slightly below the right costal border. There was nowhere any tenderness nor any source of infection discoverable. There was no leucocytosis. The urine contained a small amount of albumin. There were, however, the following signs, recorded in the notes, that are identical with those of an abscess at the dome of the liver. "The left thorax moves much more than the right on inspiration. Respiratory excursion of the lung is at the sixth, eighth and tenth interspaces in the nipple, axillary and scapular lines of the left side. The right thorax moves much less than the left on respiration. As shown by the diaphragm phenomenon and percussion, the lower border of the right lung has slight respiratory excursion at the fourth, sixth and eighth ribs in the nipple, axillary and scapular lines respectively, of the right side. The percussion note of the right lung everywhere above the band of retraction is dull, high-pitched and of short duration. There are no audible or palpable frictions over the lung, liver or spleen. The liver dullness measures 14 centimeters in the nipple-line and 16 centimeters in the midaxillary line." Here are all the evidences of an enlarged liver encroaching upon the thoracic cavity. In spite of the absence of sweating or frictions, the character of the fever, and the presence of profound icterus, an exploratory puncture for pus was made in the seventh intercostal space in the axillary line. The result was negative. The patient died on the third day of his residence in the hospital. At autopsy it was found that the signs above described were due to *pleuritis obsoleta* of the right side. The right pleural culdesac was obliterated, the diaphragm being attached at the sixth rib in the axillary line of the right side, and at the tenth rib in the axillary line of the left side. The pulmonary pleura was slightly thickened. In the small intestine were found two large *taenia saginata*. From the gall-duct a thick dark bile would exude with firm

pressure over the gall-bladder. Further than the *cholaemia* there was nothing to show the cause of death. Bouillon media inoculated from the gall-bladder and spleen proved sterile. The *pleuritis* which the patient had originally must have caused a myositis of the diaphragm, thus causing the diaphragm to be reflected against the thoracic wall by the liver ascending in the thorax. The firm organization of the exudate with the resulting adhesions, occurred before the diaphragm recovered its muscular activity.

In emphysema, the band of retraction low down in the thorax and the slight pulmonary excursion are visible on both sides. Recently I saw a patient at the City Hospital who was suffering from severe asthma and emphysema accompanying hay-fever. The lower border of the lung reached to the tenth interspace in the midaxillary line. Almost the entire hepatic area of dullness was replaced with the tympanitic note of the emphysematous lung. During inspiration, the antagonism between the auxiliary muscles of respiration in lifting the costal border and the opposing action of the diaphragm were plainly visible. The eleventh and twelfth ribs were both retracted during the inspiratory effort. The descent of the lung was visible only in the midaxillary line. A few days later the patient recovered from his asthma. The lower border of the lung was at the eighth rib in the axillary line. The normal diaphragm phenomenon was plainly visible. In a case of right-sided pneumothorax of the valvular variety in which there were strong evidences of a positive pressure in the pleural cavity, such as marked depression of the liver and displacement of the heart to the left, orthopnea, and cyanosis. I take the following from my notes: "The diaphragm phenomenon is visible on the right side, only posterior to the midaxillary line at the base of the thorax and there one sees only a band of retraction but no pulmonary excursion. On the left side the diaphragm phenomenon is plainly visible. The right pleural culdesac was full of air." If the patient is placed in a position with a strong light on the exposed thorax, the phenomenon in all its details is nearly always visible. If the entire phenomenon as described is not visible, there will at least be some evidence of diaphragmatic activity that will enable one to locate the lower border of the lung. By making comparisons between the two sides of the chest, a study of the diaphragm phenomenon will often enable us to arrive at a definite conclusion when all other physical signs leave us in doubt. I have at present under observation at the City Hospital a woman with typhoid fever who has had several intestinal hemorrhages and presents other

evidences that make the diagnosis very certain. At the base of the right thorax from the fourth rib in the nipple-line downward, and from the sixth rib in the axillary line downward the percussion note is flat and very resistant. Over this area there is no palpable fremitus. The respiratory sounds are not audible but frictions accompanying respiration are plainly palpable and audible.

These signs could be given by a pneumonia with occluded bronchi and fibrinous pleurisy, or by suppuration in the liver involving the diaphragm. On observing the diaphragm phenomenon we can in this case, with positiveness assert the former condition to be present. The diaphragm phenomenon on the right side is visible at the sixth rib in the nipple-line, and the eighth rib in the axillary line. There is a retraction-band distinctly seen, and slight excursion of the lower edge of the consolidated lung can be seen at these points. The fact that the dullness and frictions intervene between the diaphragm phenomenon and the resonant lung above, enables us to exclude hepatic abscess as the cause of the existing signs. During the past year and a half it has been our habit at the City Hospital to observe the diaphragm phenomenon in making a physical examination in the same routine manner as we study the pulse. So far as my experience goes I regard the Litten sign as one of the most valuable physical signs at our command in clinical diagnosis.

To briefly summarize the description of the diaphragm phenomenon I may say it consists of a band of retraction of the thoracic wall, marking the location of the reflection of the diaphragm against the wall of the thorax, over which band the lower border of the lung is seen to descend during inspiration.

