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ФИЗИКАЛЬНЫЕ МЕТОДЫ ДИАГНОСТИКИ ПРИ ЗАБОЛЕВАНИЯХ СИСТЕМЫ ДЫХАНИЯ И ИХ ПАТОФИЗИОЛОГИЧЕСКИЕ ОСНОВЫ. II. ПАЛЬПАЦИЯ И ПЕРКУССИЯ

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Резюме. Данная публикация продолжает цикл статей, посвященных вопросам пропедевтики внутренних болезней и ее патофизиологическим основам, в первую очередь — на материале бронхолёгочной патологии. Пропедевтика толкуется авторами широко, как введение во внутреннюю медицину, поэтому статьи содержат и терапевтический, и клинико-патофизиологический материал. Статья сопоставляет достижения и традиции отечественной терапевтической школы с принципами преподавания внутренней медицины, сложившимися в практике зарубежного медицинского образования. В данной публикации рассматривается методология пальпации и перкуссии при пульмонологических заболеваниях, анализируются патофизиологические основы интерпретации этих данных. Рассмотрены патофизиологические механизмы и феноменология пальпаторных и перкуторных симптомов, важных для диагностики бронхолегочной патологии. Вместе с тем даны как оригинальные авторские наблюдения, так и история медицинских исследований в этой области (17 рис., библ.: 22 ист.).

Ключевые слова: Бронхолёгочные заболевания; Боль в груди; Голосовое дрожание; Границы легких; Крепитация; Пальпация; Перкуссия; Физикальное обследование.

PHYSICAL METHODS OF DIAGNOSIS IN DISEASES OF RESPIRATORY SYSTEM AND THEIR PATHOPHYSIOLOGICAL BASIS: II. PALPATION AND PERCUSSION

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Abstract. This publication continues a series of papers devoted to questions of Propaedeutic of Internal Diseases and its pathophysiological basis, primarily based on the material of bronchopulmonary pathology. Propaedeutic is widely interpreted by authors as an Introduction to Internal Medicine; therefore, these articles also contain clinical pathophysiological material. The article compares the achievements and traditions of Russian therapeutic school with the principles of Internal Medicine that have evolved in the practice of foreign medical education. The article is devoted to technique of palpation and percussion in pulmonological patients as well as to pathophysiological basis for correct interpretation of these data. The article analyzes the mechanisms and phenomenology of the symptoms discovered by palpation and percussion and important for the diagnosis of bronchopulmonary diseases, along this original author's observations and history of medical studies in this field (17 figs, bibliography — 22 refs).

Keywords: Bronchopulmonary Diseases; Chest Pain; Crepitation; Lung Borders; Palpation; Percussion; Physical Examination; Vocal tremor.

Fig. 1. Nikolai Ivanovich Kotovschikov [5]

In a previous article [1] we have analyzed methodology of interviewing and visual examination in diagnosis of bronchopulmonary diseases. The continuation of the topic is devoted to touching examination and pathophysiological basis for correct interpretation of its data. This area is intermingled with palpation and percussion in cardiovascular diagnosis, which theme was discussed earlier [2–3].

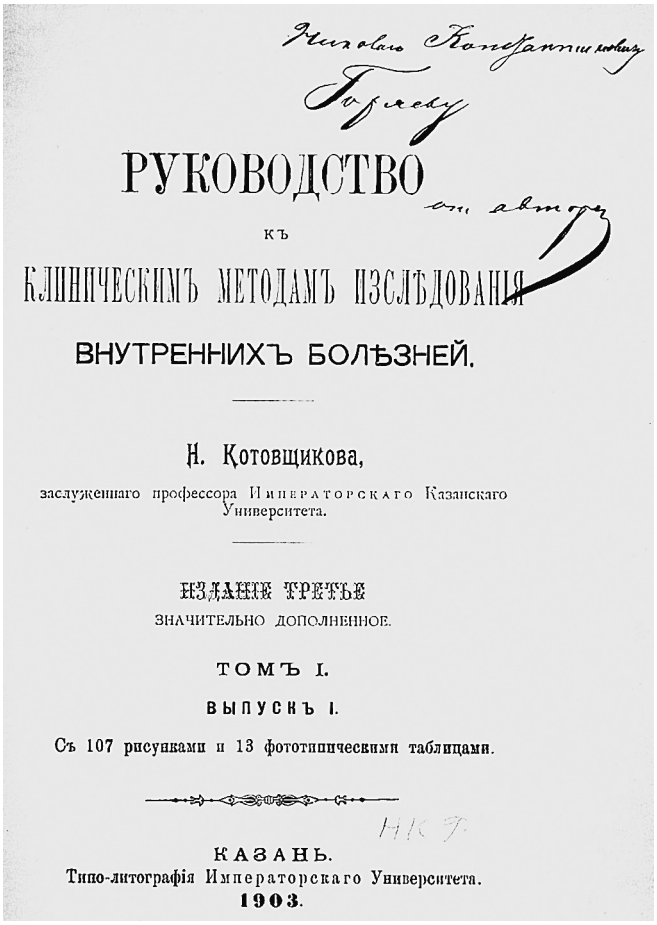
Touching medical examination techniques in history and nowadays

Two techniques of touching investigation, palpation and percussion — both the cornerstones of clinical diagnosis — are used in the physical examination of patients since ancient times and have not lost their significance to present. The genius grain of Wilhelm Conrad Röntgen's[1] discovery of 1895: X-ray scanning and radiography — fell on fertile soil, fertilized by experience of palpation and percussion, which for centuries were studied and used by medical doctors of all nations and reached their perfection in the XIX–XX centuries. This is brightly illustrated by the guidelines on internal diseases created by the classics of Russian school of Internal Medicine back in the pre-Röntgen era. A good example is the famous «Guide to Clinical Techniques of Investigation in Internal Medicine» [4] by the Professor Emeritus of the Emperor's Kazan University, Nikolai Ivanovich Kotovschikov (Fig.1).

[1] Röntgen, Wilhelm Conrad, 1845–1923, a German mechanical engineer and physicist.

Nikolai Ivanovich Kotovschikov (1846–1905) — an outstanding physician, Doctor of Medicine (1875), Professor Emeritus (1900). After graduation from gymnasium in 1864, he entered the Medical Faculty of the Emperor's Kazan University, and graduated from this school in 1869 cum laude with a gold medal. While being medical student, he interested deeply in Physiology and Pathology and since 3rd year practicised as a prosector. He published his first scientific work ("Quantitative determination of creatine in muscles") while still a medical student. After graduation, he started his career of physician under extremely challenging conditions in provincial health care system of various Zemstvos, where he had to rely mostly upon his personal skills of physical examination. In 1869–75, he worked as a Zemstvo physician and Head of the City hospital at Cheboksary. He was the initiator of the organization of the municipal dispensary, opened the first hospital in the town of Mariinsky Posad, introduced broadly medical and demographic statistics in Zemsvo health care system, founded the local Committee of Public Health (1871) and infirmary for prisoners in Cheboksary (1873). At the same time, he was engaged in research work and forensic medical expertise. In 1875 he defended a M.D. Thesis in medical chemistry. In 1875–1894 N.I. Kotovschikov was a Chairman of the Department of Medical Diagnosis and since 1894 — Director of the Internal Medicine Clinic of the Emperor's Kazan University. He was the first in Kazan University to organize proper practical classes with students on diagnostics of internal diseases, although in that period they were not yet required by the University Charter, so he donated his own funds for this improvement of teaching process. Most of his some 50 research works are devoted to diagnostics, especially in disorders of the circulation and respiration. He performed studies in pulse diagnostics, in auscultation of blood vessels and heartbeat, in percussion of the chest and abdomen, and in the biophysical origin of respiratory sounds [5]. Of special value is his main methodological work, mentioned above and published in 1885 [4] (Fig. 2). Later it passed 3 editions and was estimated by his pupil, a renoun domestic internist Alexei Nikolaevich Kazem-Bek (1859–1919), as a «capital work, which has no rival not only in Russia, but also abroad, and for a long time will be the reference book of every physician». He supplied it with the «Tables of the most important signs that characterize internal diseases» (see Fig. 3–6 below).

Let's imagine for a moment that there will be a global long blackout (which sometimes happens even in the most technologically advanced and prosperious countries, like United States of America), when all electronics, including medical ones, would fail. Nevertheless, bronchopulmonary diseases will still not go away, and heart diseases under the influence of such a calamity stress may even increase. That is why it is very important for physicians and especially for the medical students to master simple and easy methods of diagnosis: Palpation, percussion and ascultation — in order to apply them in the recognition of diseases under any circumstances, even in the absence of technological appliances. Medical doctor is a profession highly required by society during disasters and wars, when the possibility to use full arsenal of mod-


Николаю Константиновичу
Горяеву
от автора
РУКОВОДСТВО
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КЛИНИЧЕСКИМЪ МЕТОДАМЪ ИЗСЛѢДОВАНІЯ
ВНУТРЕННИХЪ БОЛѢЗНЕЙ.
Н. Котовщикова,
заслуженнаго профессора Императорскаго Казанскаго Университета.
ИЗДАНІЕ ТРЕТЬЕ
ЗНАЧИТЕЛЬНО ДОПОЛНЕННОЕ.
ТОМЪ I.
ВЫПУСКЪ I.
Съ 107 рисунками и 13 фототипическими таблицами.
КАЗАНЬ.
Типо-литографія Императорскаго Университета.
1903.

Fig. 2. Title page of the "Guide to Clinical Methods of Investigation in Internal Medicine" by N.I. Kotovschikov (3rd edition) with a dedication to his disciple, an inventor of the blood cell counting chamber, Professor Nikolai Konstantinovich Goryaev (1875–1943), who in turn later presented this book to his pupil, Professor Kuz'ma Amphyochievich Dryagin (1897–1974), who in turn presented it to his disciple, co-author of this article — Y.I. Stroyev [5] (from the personal library of Y.I. Stroev)

ern technology is often absent. Therefore, all the most advanced techniques of instrumental diagnosis, functioning thanks to electricity, still do not allow us to get rid of palpation and percussion in complex diagnosis of lung and heart patients. The famous Czech cardiologist Vratislav Jonaš (1899–1968) in his classic work "Clinical Cardiology" (1966) provides the following very interesting information [7]. The American authors tried to evaluate in percents the relative contribution of the separate research techniques for recognizing diseases of the circulatory system. According to their data, anamnesis accounts for approximately 59%, simple physical examination — for 25–30%, electrocardiological techniques — 10%, and X-ray visualization — for 5–10%. And for all other laboratory diagnosis methods, such as: Blood tests, serological, biochemical, microbiological studies, urinanalysis, vital capacity measurement, and various hemodynamic functional tests, taken alltogether — there remains a share of just 5%!

PALPATION

The palpation is informative method of physical diagnostics in bronchopulmonary diseases. It gives the possibility to localize the chest pain and judge about its spreading and probable local (cutaneous hyperalgesia, intercostal neuralgia) or more profound (costal trauma, vertebrosternal lesion) etiologies.

In costal fracture over the lesion spot there is a characteristic crackling or rattling sound — so called crepitation. Palpable crepitation of subcutaneous fat due to air bubbles in it (hypodermic emphysema) produces an impression, which is difficult to forget. This phenomenon may occur after pneumothorax, in lung wounds, after unintended lung puncture during subclavicular venepunction manipulation.

By the palpation medical doctor can evaluate the extent of chest elasticity or degree of its resistance. Several processes, like exudative pleuritis, pleural tumors, and senile ossification of the costal cartilages — may result in increased thoracic resistance and palpable chest rigidity. The palpation of lung apex areas and *musculus trapezius* may be unpleasant and even painful in patients with apical dry pleuritis and pleural tuberculosis.

Sometimes palpation may reveal pulsations (this phenomenon in purulent pleuritis is known as *empyema pulsans*). In case like this the heartbeats are palpable through purulent pleural exudate, juxtaposed to the heart. The tumors located in close vicinity to the heart also may pulsate on chest palpation (mesothelioma of pericardium or neoplasms of lower mediastinum). Some auscultative phenomena, e.g. dry râles and pleura friction rub — are also palpable [8–12].

Finally, chest palpation allows to investigate so called "*fremitus vocalis seu pectoralis*" (vocal fremitus, a kind of vibratory tremor, provoked by vocalization). This is low amplitude trembling of thoracic wall produced by vibrations of vocal organs.

It is well recognized by the touching palms, attached symmetrically to the patient's chest. The palms delineate the fremitus more precisely than the fingers do. For the fremitus registration ask the patient pronounce loudly when palpating some words and phrases, requiring most intensive vocal vibration (like Russian 33 — "*tridtsat' tri*"). Probably, English words like: "deteriorate" "territory" could present partial analogue, but because of the specific of "r" phonetics in English speech, as a rule British and American colleagues prefer to ask their patients to say loudly "99" or "blue moon".

The stronger the voice and thinner the thoracic wall — more robust will be the phenomenon of fremitus. Hence, in females, in children, in oedematous or obese patients vocal fremitus is weakened, as well as in exudative pleuritis [8–9].

If the lung tissue is infiltrated by inflammatory exudate and consolidated, the fremitus vocalis is strengthened. Pulmonary caverns and large bronchiectases also increase the tactile vocal tremor by resonating. In emphysema, vice versa, fremitus is greatly weakened.

It is also weak if there is air or tumor located in pleural cavity and producing shield effect. Right bronchus is shorter and broader than left one, thus normally causing more noticeable fremitus from right side [10–11].

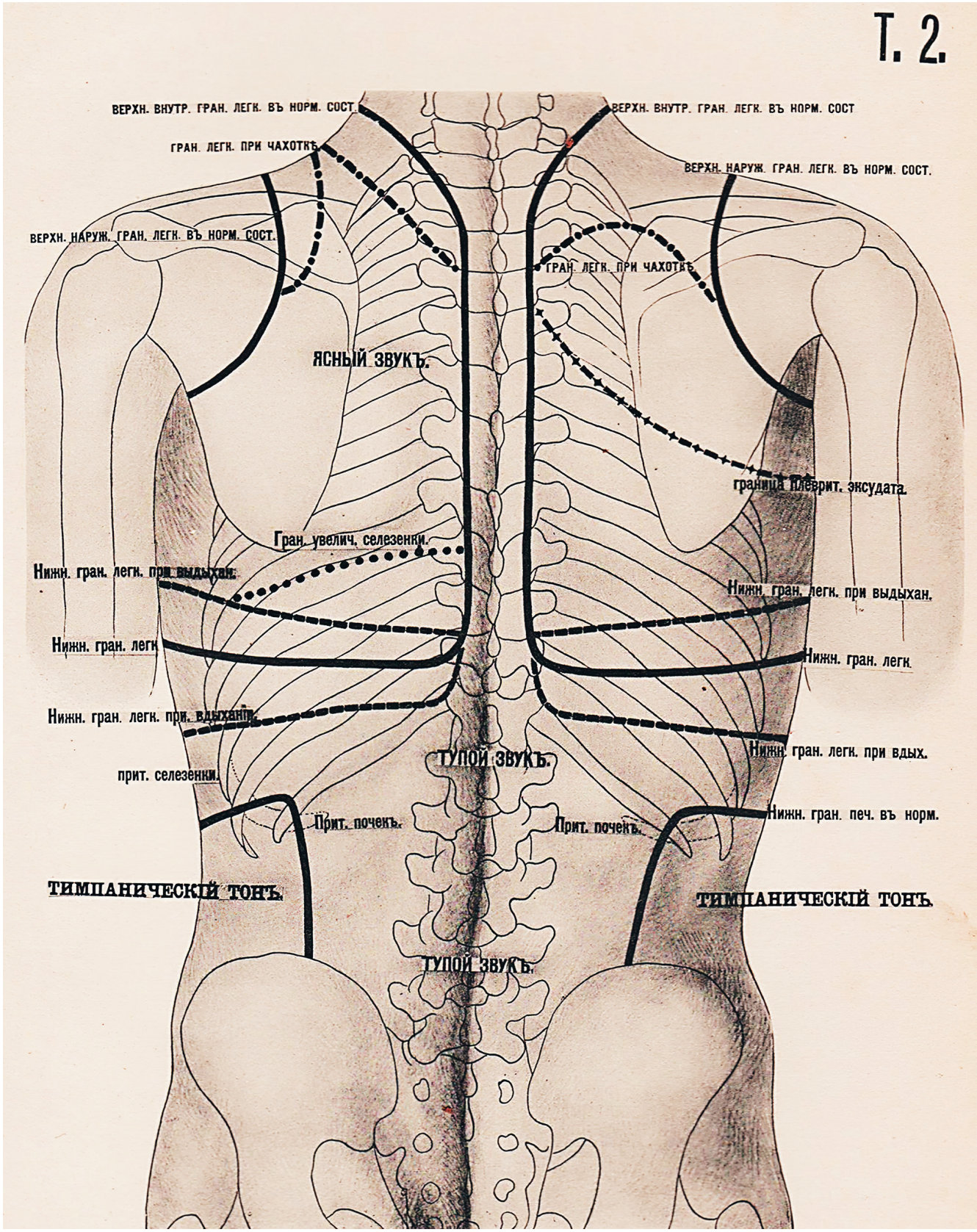


Fig. 3. Percussion data scheme for posterior chest surface in various bronchopulmonary and spleen diseases by N.I. Kotovschikov, 1903 [4]

PERCUSSION

The chest percussion is a compulsory method of physical examination in bronchopulmonary diseases diagnostics. Percussion is an assessment technique which produces sounds by the physician tapping on the patient's chest wall. It may give the information about the properties and extent of aerial content in those organs, lying under the points of percussion.

The percussion of patient's chest is to be performed in standing or sitting position. The upper muscles of the chest and arm must be relaxed to avoid the percussion sound distortion.

If there is a need to use percussion in weak, severely ill persons, they must be supported by nurses or relatives during procedure. If the patient can not stay in vertical posture at all, doctor has to limit the percussion only doing it in lying position, which, of course, methodologically is not desirable.

In lying position only comparative percussion of anterior and axillary areas of the chest is possible. Physician's position during procedure must be most convenient for informative percussion [8–12].

The percussion as a technique is divided into topographic and comparative one. Topographic percussion is designated for the delineation of the lower lung borders.

Lower lung border by posterior scapular line from both sides is normally located over 10th rib (Fig. 3). In emphysema the lung borders are expanded because of increase in residual volume of lungs down to 12th rib. The detailed scheme of percussion data for posterior chest surface was given by N.I. Kotovschikov in his comprehensive guide [4].

From anterior surface of the chest low border of left lung is not determinable due to close-by heart dullness and existence of Traube[2] space (gaseous bubble of the stomach). The discoverer of this space also made great contribution into Pulmonology by his description of bradypnoea [1] and introduction of the first lung functional test with breath holding (Traube's test) for diagnosis of latent respiratory insufficiency. He also was the first who introduced in clinical practice daily drawing of body temperature plot. We publish here the portrait of this physician and scholar, who was in fact the founder of Clinical Pathophysiology (Fig. 4).

The topographic percussion reveals the excursions of the lung margins and helps in assessment of its symmetry.

Lung margin excursion is determined by difference between lower lung border on maximal inspiration and on maximal expiration. Normally it is 6–8 cm measured by axillar lines. Many disorders of restrictive character are accompanied by tachypnoea [1], limiting lung excursions. That's why in pleural adhesion, in severe pain resulted from dry pleurisy, and in marked emphysema — limited lung margin excursion can be registered.

In normal lung the interlobar borders are not recognizable by chest percussion. But in some diseases (lobar pneumonia, interlobar exudative pleurisy) — the interlobar borders are clearly detectable by percussion of chest walls [10–12].

Fig. 4. Ludwig Traube

It is well known, that from posterior chest surface only two lung lobes are tangible from both sides, but from ahead — three lobes (Fig. 5) are cognizant in right lung (these are the upper, middle and lower lobes). That was also clearly depicted in classic book by N.I. Kotovschikov [4]

The basic rules of correct topographic percussion are the following:

1) Pleximeter finger must be located in parallels with the border of the dullness under check;
2) Percussion proceeds from clear sound — towards dull one;
3) Lung borders should be determined by smooth percussion;
4) The side of the finger nearest to the lung locates the border [9].

The height of the lung apex is checked at the frontal side over the clavicle, but at the back side — over *spina scapulae*. Smoothest percussion technique, by Pleisch[3] (when pleximeter finger is bended) commonly should be used for it (Fig. 6).

Normal protrusion of the lung apex from the frony side reaches the point 3–5 cm over clavicle and from behind — it reaches the level of 7th cervical vertebra [10].

[2] Traube Ludwig, 1818–1876, an Austrian (after 1869 — German) internist and clinical pathophysiologist.

[3] Plesch János Oscar, 1878–1957, a Hungarian (after 1933 — British, in 1951–54 — Swiss, after 1954 — American) in-ternist, pathologist, family physician and friend of Albert Einstein, 1879–1955, a German-born (after 1896 — Swiss, after 1933 American) physicist.

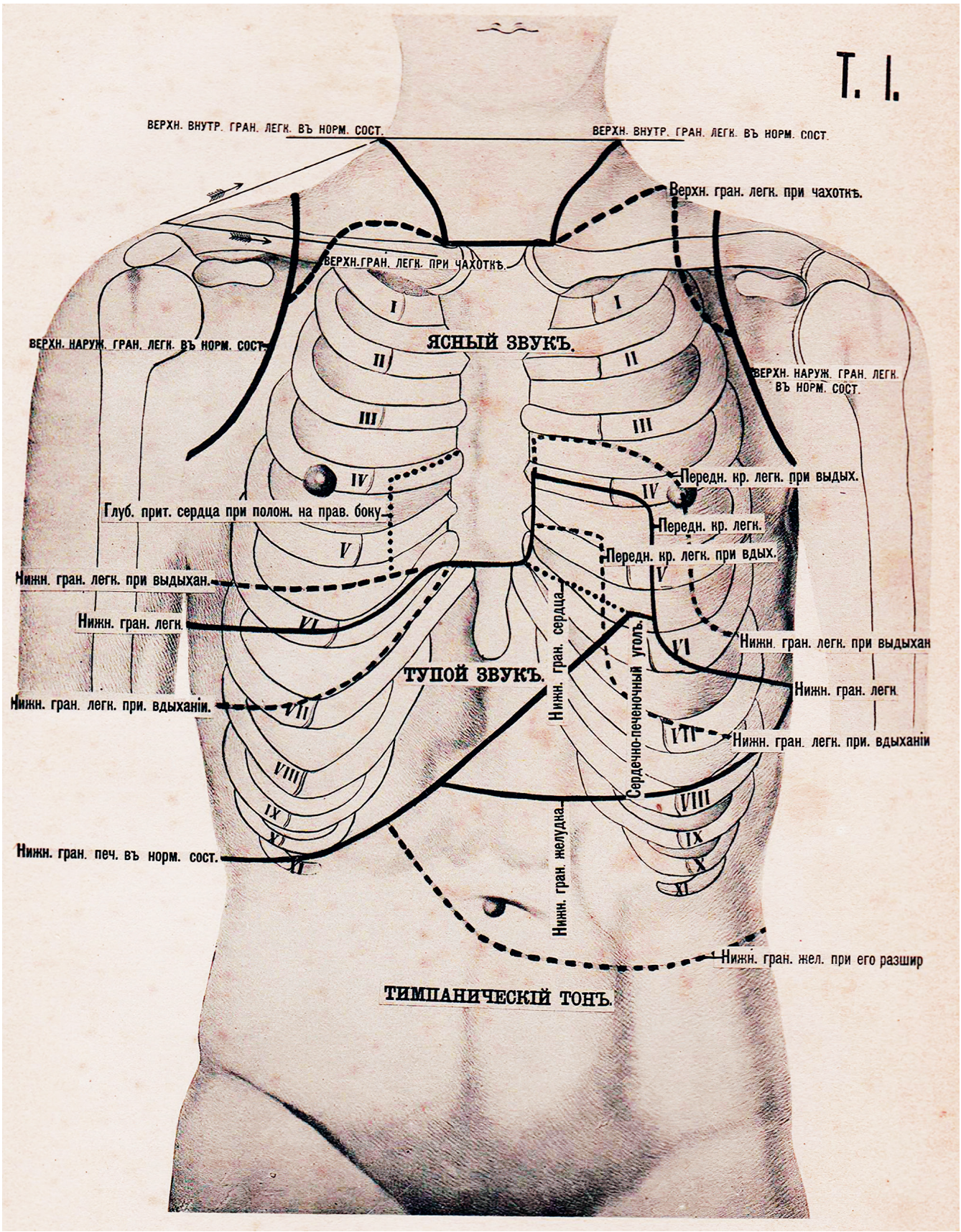


Fig. 5. Percussion data scheme for anterior chest surface in various bronchopulmonary diseases by N.I. Kotovschikov, 1903 [4]

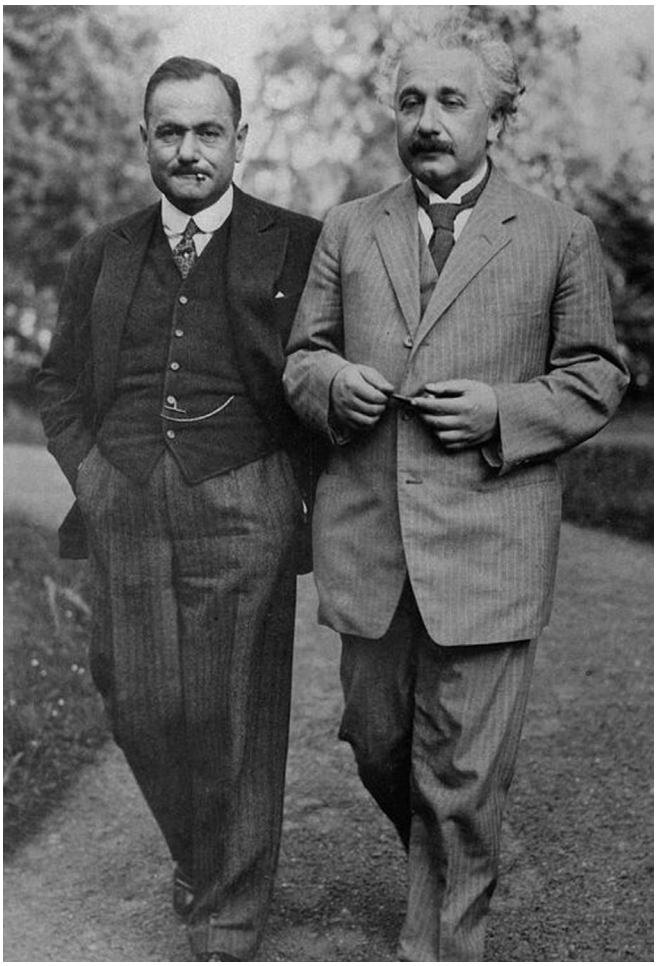


Fig. 6. J.O. Plesch (left) and his lifelong friend and patient — A. Einstein [13]

Checking the apexes of both lungs, it is worth to determine so called Kroenig's fields[4] (Fig. 7).

These fields (areas) are delineated by means of percussion along the upper edge of musculus trapezius from the middle point of the muscle to both sides. Normal width of Kroenig's fields is 4–8 cm.

But the symmetry of Kroenig's fields is much more important than merely their size, which varies greatly. Kroenig's areas asymmetry may result from unilateral apical fibrosis or consolidation, which is especially significant in diagnostic of upper lobe tuberculosis, often involving lung apex [10, 12].

There is also term: Kroenig's isthmus. It is narrow strap-like portion of the resonant field that extends over the shoulder, connecting the larger areas of resonance over the pulmonary apex in front and behind.

High position of lower lung boundary may result from high phrenic muscle location due to ascites, pregnancy, flatulence, severe obesity, or large abdominal cysts and tumors.

[4] Kroenig Georg, 1856–1911, a German physician (sometimes in English literature his name is misspelled as "Kronig")

Fig. 7. Georg Kroenig

Comparative (symmetric) percussion has the goal to obtain the information about physical (anatomic) status of the lung. It is always performed accurately at symmetric points. The precise symmetry is essential because even imperceptible difference in shape or status of thorax, slightest curvature of backbone or unequal muscle development from left abd right sides — may change the character of the sounds [8–9].

The comparative percussion proceeds according the following standard consequence:

1) Apexes;
2) Anterior surface along the intercostal spaces;
3) Lateral surfaces (patient must keep both hands on his/her head);
4) Posterior surface (over scapulae, interscapular area, and below the scapular corner).

In interscapular area a pleximeter finger is positioned in parallels with the backbone, below the scapulae — it locates along the intercostal spaces.

CLASSIFICATION OF PERCUSSION SOUNDS

The pioneer of Thoracic Medicine, an outstanding Czech-Austrian physician Joseph Škoda[5] (Fig. 8) in his classic book

[5] Škoda Joseph, 1805–1881, a Czech-Austrian physician and clinical pathophysiologist.

Fig. 8. Joseph Škoda

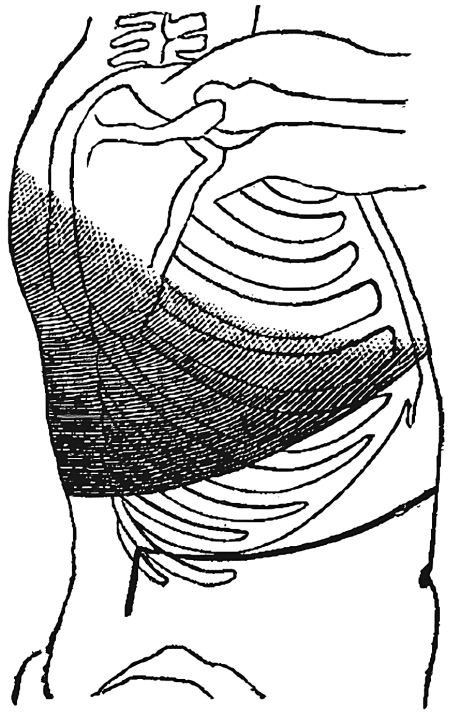


Fig. 9. Dullness area in effusion pleurisy (by N.I. Kotovschikov, 1903) [4]

devoted to percussion and auscultation [14] has classified the percussion sounds as follows:

1) Clear and loud;
2) Dull (dullish);
3) Full or prolonged;
4) Empty or short;
5) High;
6) Low;
7) Tympanitic resonance;
8) Non-tympanitic.

First type of percussion sound, according Škoda's classification, is produced by percussion over normal lung tissue. Its timbre is usually not musical. Its altitude and amplitude depend on age, subcutaneous fat amount and chest muscle development and individual properties of the thoracic wall.

Second one (dull) is called sometimes "femoral sound" because it is produced also by percussion of the thigh. It is audible during percussion over the inner organs, adjacent to thoracic wall (heart, liver, and spleen — which corresponds to cardiac, liver, and spleen dullness). Dull sound over lung is resulted from decrease of aerial content or absence of air in some portion of lung.

It has several pulmonary or extrapulmonary reasons:

Pulmonary reasons of dull lung percussion sound are listed below:

1) Bronchopneumonia;
2) Lobar pneumonia in hepatization phase;
3) Pulmonary tuberculosis;
4) Lung abscess;
5) Large pulmonary infarction and pulmonary hemorrhage;
6) Lung tumors;
7) Pulmonary oedema, especially in lower lobes;
8) Atelectasis.

The scars in the lung also cause dullness of percussion sound.

Dull sound may be also of pleural origin: Due to fluid or tumor presence in pleural cavity, or massive adhesions of pleural layers. It is observed in exudative pleuritis, hydrothorax, and mesothelioma — even if the lung itself is not involved [9–10, 12, 14].

The upper border of the dullness caused by intrapleural fluid has the explicit shape, named after its eponymous discoverers — as Damoiseau–Ellis line[6] (Fig. 9).

Negative pressure in pleural cavity together with adhesion and gravitation forces create this line of dullness; this is a characteristic parabolic curve with the highest point along the axillar line, indicating the upper percussion border of exudate in effusion pleurisy. Its shape is a biophysical result of the vector summation of two forces — surface tension and gravitation, which was demonstrated by August Ladendorf's simple experiment (Fig. 10).

The curved shape of exudate upper limit is also due to the fact that the exudate is rich in cell adhesion molecules, so in the

[6] Damoiseau, Louis Hyacinthe Céleste, 1815–1885 (other sources mention 1815–1890) — a French physician, discovered a phenomenon in 1844; Ellis, Calvin, 1826–1883 — an American physician, added description in 1874.

pleural cleft it adheres to the pleura sheets at negative pressure without forming a gravitational horizontal level (Fig. 11).

Note, that the line is clinical, not roentgenological, although its equivalent shadow is registered also by X-ray. But, if the pleural cavity contains some air together with fluid (in hydropneumothorax) the oblique Damoiseau–Ellis line on percussion is not detectable and instead of it the upper limit of dullness forms horizontal line along the gravitational fluid level (Fig. 12).

We failed to find a photo of the French discoverer, L.H.C. Damoiseau, although his American follower — C. Ellis is portrayed in Fig. 13. But our search gave an unexpected result. It seems that Dr. Damoiseau was not only the discoverer of an important percussion symptom, but also one of the pioneers of Physiotherapy and a scholar among the first clinicians who coined an idea of artificial circulation apparatus. At least, in the National Library of France we came across his book, published in 1862, when he was a senior intern of the Paris hospital [17]. Its title (translated from French) is "The Terabdelle or pneumatic machine operating at will local bleeding and revulsion to the main regions of the human body". It describes a sort of physiotherapeutic device, invented by this physician, a suction pump, which draws blood portions to certain organs or parts of the human body. It was actually constructed and successfully tested by the author in French Academy of Sciences. In a hope that the picture on cover page of this book is correctly portraying the inventor, Dr. L.H.C. Damoiseau, we publish it here as an example of early Translational Medicine and Medical Engineering thought (Fig. 14).

As a result of mediastinum displacement by exudate in effusive pleurisy, the zones of less resonance loss may be formed. A paravertebral area, approximately triangular in shape, with relative resonance of varying intensity (up to tympanitic) in the lower back, between the spine and Damoiseau–Ellis line, found in the same side as a pleural effusion [18] was described in 1874 by G.M. Garland[7] and now is named after him — Garland's triangle. The Medicine is an international science; there is no national Medicine, just the national health care systems. Here is a bright example. Another triangular area of dullness at the base of the chest near the spinal column, on the side opposite a pleural effusion, which most commonly seen in children and adolescents [18], was first noticed by an Austro-Hungarian physician Friedrich von Korányi (1880). After that an Italian physician Pietro Grocco (1902) added to the description of this phenomenon and Russian pediatrician of German origin from Saint Petersburg — Karl Andryevich Rauchfuss[8] (1904) completed it and introduced its percussion into broad pediatric practice. Our earlier article already described this symptom as well as the legacy of last medical doctor [19]. Percussion sound altitude depends on the number of oscillations in percussion. Expanded lungs give birth to low tones

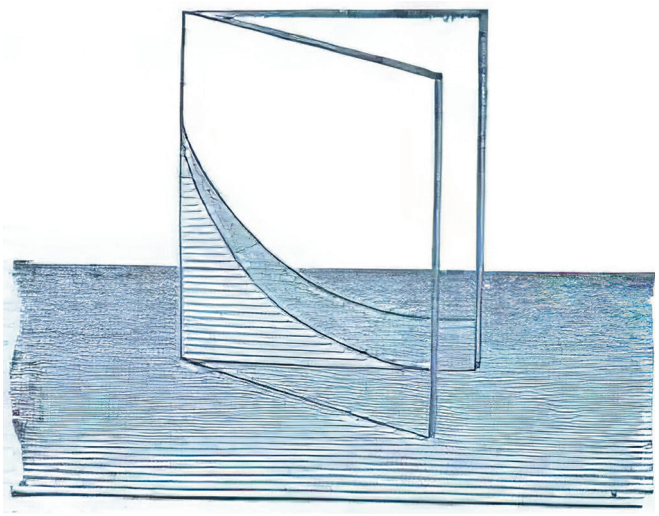


Fig. 10. Ladendorf's experiment. The shape of the upper border of the exudate is identical to that obtained if two glasses are placed at an acute angle in the wetting liquid. It is known that the liquid goes up, and the higher the smaller the distance between the glasses (1878) [15]

(it occurs in emphysema, or in bronchial asthma). High tones are produced if there is limited area of infiltration within the lung tissue (e.g. in initial stage of apical tuberculosis) [9–10, 20].

Returning to Škoda's classification of percussion sounds given above, it is necessary to mention that "short or empty" sound (# 4) is produced by the percussion of the portion with less content of air (e.g., due to its infiltration). Principally, dullness and shortness of percussion sounds are not identical.

The tympanitic sound (# 7, the term goes from Greek *"τύμπανον"* — tambourine or frame drum) is close to musical as it is possible to evaluate its altitude and even copy it by the voice. The shorter the column of air, trembling in process of percussion, the higher will be the tympanitic sound, the more musical it will be. This sound is produced over the areas of chest, adjacent to air-containing cavities. Normally it is heard only over the abdominal Traube's space (see above).

In disease it may occur if:

1) Fluid collected in pleural cavity and the lung rises over exudate level (this phenomenon is called "Škodaic resonance");
2) Exudate in pleuritis presses over lung, but its layer is thin;
3) There is a relaxation of upper lobe due to inflammatory infiltrate of lower lobe;
4) There is simultaneous presence of air and fluid in alveoli due to oedema of the lungs or croupous (lobar) pneumonia in rush phase without resolution.

Percussion may produce tympanitic sound over the air cavities with smooth walls if the diameter of cavity is not less than a walnut one. The walls of cavity must be resilient enough to establish drum-like effect. If the air cavity is situated deep, it is disclosed by percussion only if its size is large (like, for example, that of physiologic cavities: Laryngeal, tracheal, stomach, and intestinal, the last may be located within thorax in case of large diaphrag-

[7] Garland, George Minott, 1848–1926 — an American internist and physiologist.

[8] von Korányi, Friedrich, 1828–1913, an Austro-Hungarian internist; Grocco, Pietro, 1856–1916 — an Italian internist, (see also [1]); Rauchfuss Karl Andreyevich (aka: Reuchfuss, Carl Gottlieb), 1835–1915 — a Russian pediatrician (see also [19]).

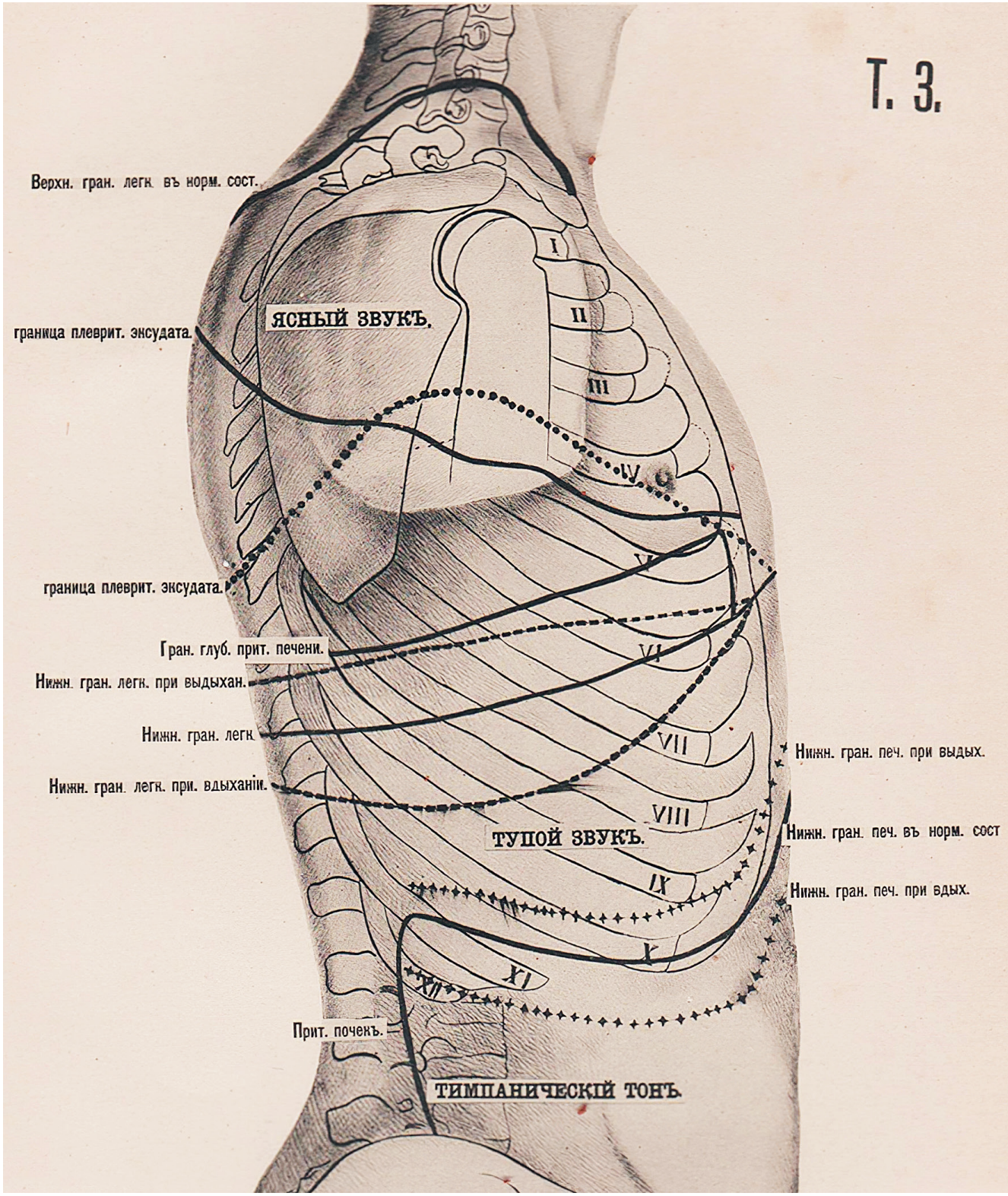


Fig. 11. Scheme of chest percussion data in right-side exudative pleuritis (by N.I. Kotovschikov, 1903) [4]

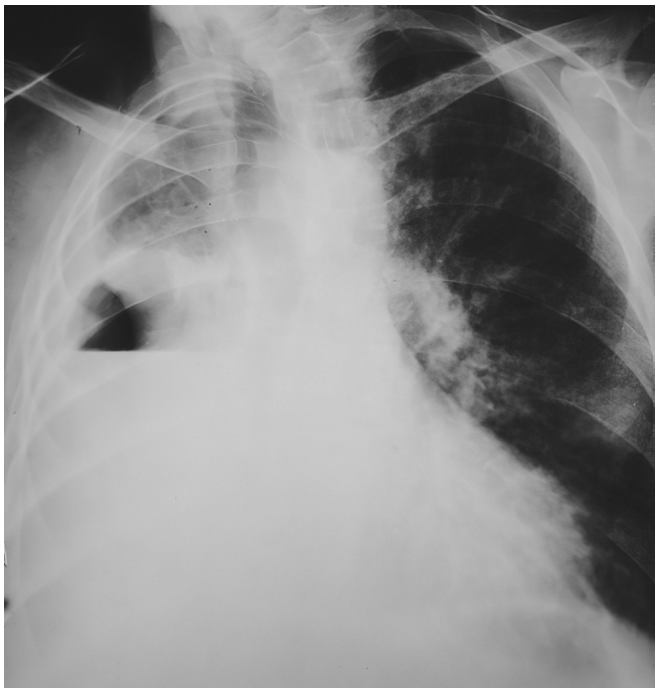


Fig. 12. Chest X-ray in hydropneumothorax with horizontal level of exudate (case observed by Y.I. Stroev

matic hernias). The lagre pathological cavities also revealed by percussion are: Giant caverns, pneumothorax, of bronchiectases [8–12, 14, 20].

The generalized hyperresonance or "bandbox sound" described by M.A. Biermer[9] (Fig. 15) is a transient acoustic phenomenon between tympanitic and non-tympanitic ones. It resembles closely the sound, produced by knocking on the empty box. It may be observed in loss of lung elasticity (chronically caused by emphysema or acutedly occurring in bronchial asthmatic attack).

The Laennec 's metallic tinkling is produced over smooth-wall caverns, which are greater than 6 cm in diameter, also it is heard over pneumothorax and pneumopericardium areas. The next figures demonstrate the chest in cases of spontaneous or iatrogenic curative pneumothorax (Fig. 16–17).

R.-T. H. Laennec[10] whose discoveries in auscultation we described in one of previous articles of this cycle [21], also has described another kind of percussion pnenomenon: Cracked-pot sound or originaly "bruit de pot fêlé" — in French.

It is reproduced by beating the knee with the palms joined together. It may occur in health — in small children during the crying or forced expiration. In disease this phenomenon is typical for

[9] Biermer, Michael Anton, 1827–1892, a Swiss internist

[10] Laennec, René-Théophile-Hyacinthe, 1781–1826, a French physician and musician. See also [21].

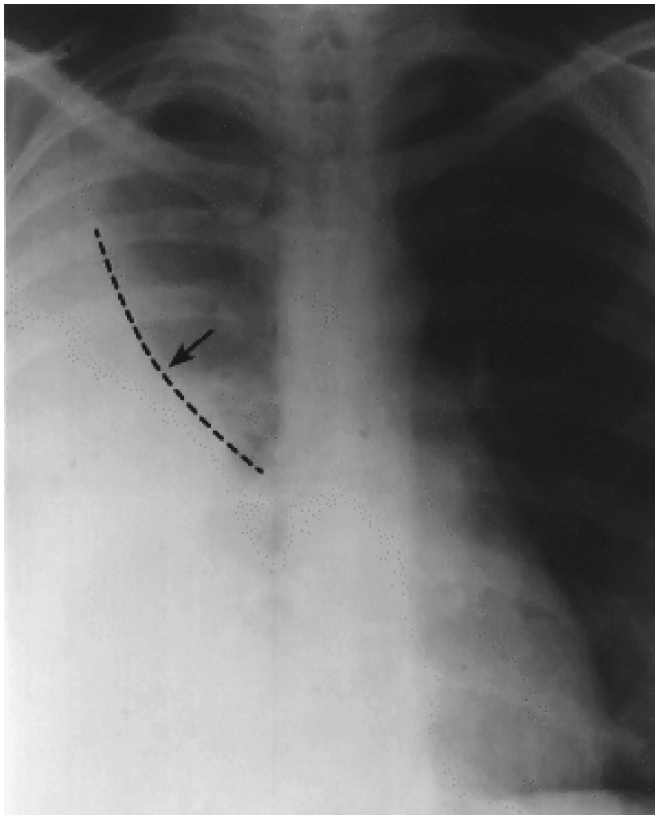
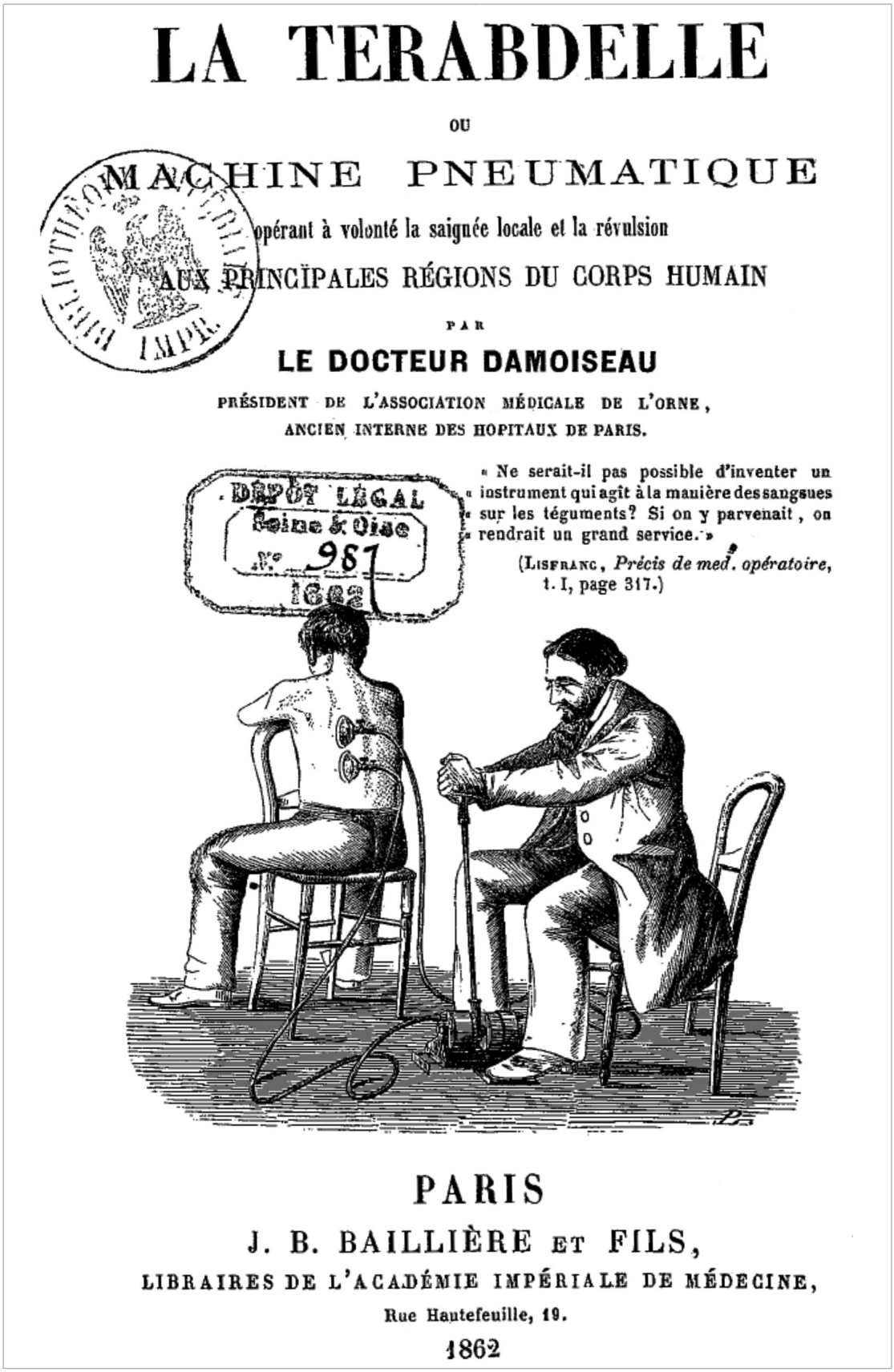


Fig. 13. Left: Damoiseau–Ellis line (arrowed) on chest X-ray of a female patient B., 32 years old. Diagnosis: Effusion pleurisy. A case observed by Y.S. Stroev [16]. Right: Calvin Ellis



LA TERABDELLE

OU

MACHINE PNEUMATIQUE

opérant à volonté la saignée locale et la révulsion

AUX PRINCIPALES RÉGIONS DU CORPS HUMAIN

PAR

LE DOCTEUR DAMOISEAU

PRÉSIDENT DE L'ASSOCIATION MÉDICALE DE L'ORNE,
ANCIEN INTERNE DES HOPITAUX DE PARIS.

« Ne serait-il pas possible d'inventer un instrument qui agît à la manière des sangsues sur les téguments? Si on y parvenait, on rendrait un grand service. »

(LISFRANC, *Précis de méd. opératoire*, t. I, page 317.)

PARIS

J. B. BAILLIÈRE ET FILS,

LIBRAIRES DE L'ACADÉMIE IMPÉRIALE DE MÉDECINE,

Rue Hautefeuille, 19.

1862

Fig. 14. Dr. L.H.C. Damoiseau (?) testing his "La Terabdelle" machine [17]

Fig. 15. Michael-Anton Biermer

lung cavities joined with bronchus through narrow aperture or in pneumothorax communicating with bronchus (see previous article of this cycle [1] with a chest X-ray on its Fig. 1).

This sound characteristically becomes clearer if the patient will open his/her mouth. The cracked-pot sound may acquire metallic tune. It is produced by the jingling of air, moving through the narrow aperture, portion by portion, with pushes [22].

The heritage of classic Internal medicine is still alive srving to contemporary physicians along with modern instrumental and laboratory methods of diagnosis.

Fig. 16. Chest X-ray in right side spontaneous pneumothorax. Case observed by Y.I. Stroev

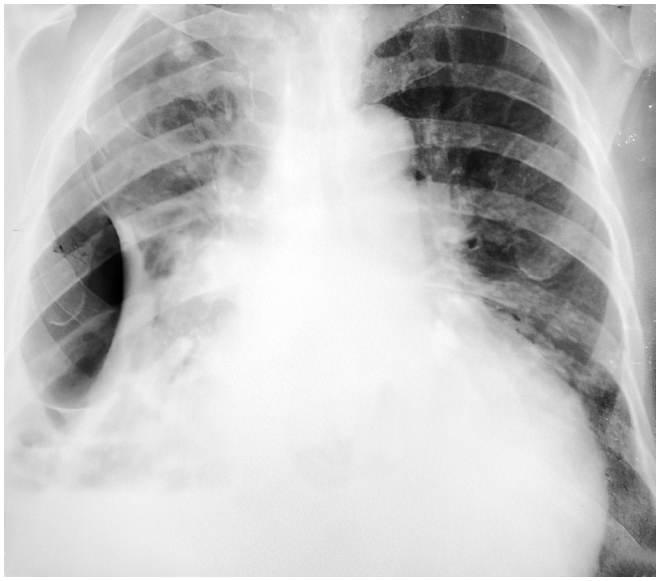


Fig. 17. Chest X-ray in right side iatrogenic artificial pneumothorax applied for treatment of lung tuberculosis patient. Case observed by Y.I. Stroev

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