

Original Articles.

X-RAY EXAMINATIONS AN AID IN THE EARLY DIAGNOSIS OF PULMONARY TUBERCULOSIS.¹

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It is well understood that the most important step in the cure of many diseases is their early recognition. A striking example of this is the cure of more than nine-tenths of the patients who have diphtheria, when they are properly treated in its very earliest stages. While we have no drug like antitoxin with which to treat pulmonary tuberculosis, it is universally recognized by those who have had a large experience that in a considerable proportion of patients, provided this disease is recognized in its earliest stages, success even in our climate follows suitable hygienic and dietetic treatment if intelligently and persistently carried out; therefore any method which helps us to an early diagnosis is valuable.

Hitherto we have depended for early indications of this disease upon, for example, loss in weight, a slight daily rise in temperature, anemia, a disordered digestion, a rapid pulse, etc.. Only one or two of these symptoms may be present in any one case, and they may be due to other causes than tubercle bacilli; but if to some of these be added a morning cough or hemoptysis, we have more reason to suspect the lungs as being the seat of disease, and still more if we find râles or signs of consolidation at the apex of one lung; expectoration if found to contain bacilli establishes the diagnosis; but these latter signs and symptoms occur often in a somewhat later and more marked stage of the disease than the one I am about to consider.

The signs to which I wish to again direct the attention of the profession are those seen by means of an x-ray examination, for in some cases an abnormal condition of the lungs may be observed with the fluorescent screen before many of the above signs have appeared. We may thus detect indications of a departure from the normal in the lungs of patients in whom this disease was previously unsuspected, or in whose lungs the signs had been overlooked by auscultation and percussion. The attention having been directed to a certain portion of the lungs by means of the fluoroscope, an increase in the fremitus or prolonged expiration may be observed which had not been noticed previously.

I shall present briefly, as examples of the use of x-ray examination in early pulmonary tuberculosis, two groups of three cases each, taken from a larger number:

(1) Those in which there were râles or cough or expectoration.

(2) Those in which there were no râles or cough or expectoration.

The signs obtained by me through auscultation and percussion in a number of my patients were essentially the same as those obtained by other physicians from our own or other States, who had come to see my methods of x-ray examination. The diagnosis was confirmed in all these cases later by finding tubercle bacilli or by the tuberculin test. I will now outline briefly three cases in which there were cough or râles in addition to other signs of pulmonary disease.

First Group.—In this first patient the difference be-

tween the signs by auscultation and percussion and the x-ray examination is not as marked as in some others; from the latter, however, it would be fair to suspect the right apex also, though there were no physical signs on that side.

J. H., twenty-three years old; at Boston City Hospital November 1896; cough for about one year; yellow expectoration with some blood occasionally; no loss in weight, no night sweats.

Physical Examination of Lungs.—Slight dulness at left apex front and back, occasional moist râles, voice sounds slightly increased, prolonged expiration.

X-Ray Examination.—The apices of both lungs as far as the second rib darker than normal. Excursion of the diaphragm on the right side $2\frac{1}{4}$ inches, on the left side $1\frac{1}{2}$ inches. (The average excursion in health in 45 adults was $2\frac{1}{2}$ inches on the left side and $\frac{1}{2}$ inch more on the right; in younger adults the excursions were greater than in the older.) Eight days later a second x-ray examination was made, which corresponded with the first. Tubercle bacilli were found.

In the following case I should have made the diagnosis of chronic bronchitis but for the x-ray examination; the appearances thus observed were confirmed later by finding the tubercle bacilli.

T. E., chronic bronchitis, fifty-six years old. Entered the City Hospital February, 1897. Good family history. Husband died of consumption. Present illness: cough for some months, considerable expectoration, especially in the morning; no pain; dyspnea on exertion, weakness.

Physical Examination of the Lungs.—Chest walls thin. Both chests hyper-resonant in front and back; breathing rather harsh; expiration prolonged, a few coarse, moist râles in backs.

An x-ray examination made at this time showed that the diaphragm moved on the right side 2 inches and on the left side only $1\frac{1}{4}$ inches. No bacilli were found in the expectoration.

In January, 1898, she returned to the hospital. She had had several small hemoptyses; there were indefinite physical signs in both apices behind.

An x-ray examination showed a very limited movement (less than half an inch) of the diaphragm on the left (before, it had been $1\frac{1}{4}$ inches), and the whole of the left lung less clear than the right, and the movement of the right side was only $1\frac{1}{4}$ inches, where it had been 2 inches eleven months before. The apex of the right lung also was darker than normal. Tubercle bacilli were found.

J. G., twenty-eight years old, a patient who was referred to me for an x-ray examination by Dr. H. D. Arnold. The history indicated tuberculosis, but though the patient had caught cold six weeks before, and had had a cough and severe attacks of hemoptysis afterwards, the physical signs were indefinite.

By Dr. Arnold's physical examination the signs pointed to the left apex as the seat of the disease. There was slight dulness, diminished and harsh respiration, and slight increase in tactile fremitus in front. Two other excellent physicians also chose the left rather than the right side as the one on which the disease was chiefly located.

An x-ray examination indicated that the right, not the left, side was the chief seat of the disease. The

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lung from the apex nearly to the nipple line was, even to untrained eyes, obviously darker than the left side, and the excursion of the diaphragm was less on the right side than on the left side ($1\frac{3}{4}$ inches on the right, $2\frac{1}{2}$ on the left side). Ten days later the second *x-ray examination* showed the same appearances at the right apex. The excursion of the diaphragm was 2 inches on the right and $3\frac{1}{4}$ inches on the left.

This patient entered the hospital and was in my service for a week. Several physical examinations were made, always showing slight signs only; no râles were heard except once, when my house physician, Dr. Cronin, found a few in the right back below the scapula. The diagnosis was confirmed by finding tubercle bacilli.

These first three cases show that more marked and definite signs may be found in the lungs by an *x-ray examination* than by auscultation and percussion, and one of them, that the physical signs and history may lead the physician to think that he has to do with a chronic bronchitis, for instance, when an *x-ray examination* suggests pulmonary tuberculosis.

Second Group.—I will now outline three cases in which there were not marked signs in the lungs by physical examination. *X-ray examinations* showed an abnormal condition of one lung and reaction to the tuberculin test showed the presence of tuberculosis.

The following patient had no signs in the lungs by auscultation and percussion.

M. T., twenty years old. Entered the Boston City Hospital April 21, 1897.

Diagnosis.—Phlebitis of the leg, anemia.

Family history: Two sisters died of phthisis. **Personal history:** Five weeks ago had pain in right calf; two weeks ago pain in left side, worse on breathing. Heart area, action, and sounds normal. Lungs, good resonance and respiration over all.

May 12th. *X-ray examination* showed right apex darker to third rib; excursion of diaphragm, right side $1\frac{3}{4}$, left side 2 inches.

May 22d. Tuberculin given. Temperature 104° . A well-marked reaction followed.

May 27th. Nothing found in lungs. Murmur over base of heart. No cough. Well developed and well nourished.

June 12th. Several physical examinations of lungs give no evidence of tuberculous process. Resonance and respiration good. Patient has a pale, pasty look, is short of breath, and still rather weak.

F. A., nine years old, school boy.

Diagnosis.—Typhoid fever.

Family history good. **Personal history:** Had diphtheria three years ago, otherwise has always been well. For the past month has felt poorly; went to bed a week ago; complains of pain in the epigastrium and in front of chest. Has headache and feeling of weakness. Appetite poor and sleeps poorly. No chills, no nosebleed, no cough. Well-developed and well-nourished boy in excellent general condition. Color good. Sent to the hospital with the diagnosis of typhoid fever; had at entrance a temperature of 100° ; pulse 108, regular and rather weak. Enlargement of the spleen, questionable; no rose spots. Serum reaction negative. Liver dulness from sixth rib to one finger's breadth below costal border.

Lungs: In right apex in front and behind there is an increase in vocal resonance and fremitus and whispered brouchophony. Lungs otherwise normal. No change in percussion note and no râles heard.

November 18th. By percussion over the heart the dull area was found to be increased to the right, but in a few days this enlargement disappeared. The temperature had run a slightly elevated course, 99° morning, 100° evening, for some days; this is, I think, suggestive of tuberculosis.

November 22d. *X-ray Examination.*—The right lung above the fourth rib not so bright as left. Excursion of diaphragm shorter and higher up on right side than on left side, $1\frac{1}{4}$ inches on the former, 2 inches on the latter. Heart enlarged to right.

November 27th. One milligramme of tuberculin given. No reaction.

December 1st. Three milligrammes of tuberculin given at 6 p. m. The following day at 11 A. M., temperature 102.5° ; marked malaise.

December 3d. Second *x-ray examination* ten days after first; signs of the two corresponded.

December 5th. Was discharged, having been up and about the ward for some time. General condition good. No cough, and appears perfectly well. Sleeps well; appetite good; color excellent. This patient was in the hospital eighteen days under careful observation.

On February 27, 1899, he came to me for another *x-ray examination*. I found the upper portion of the right lung darker than the left, and the excursion of the diaphragm on the right side $1\frac{1}{4}$ inches, on the left side $1\frac{3}{4}$ inches. There was some dulness by percussion over the upper portion of the right lung in front. His condition was, I think, not quite as good as when I saw him in December; he looked a little pale.

In the next patient, my only reason for making an *x-ray examination* was to determine the size of the heart, and while doing this I saw that one lung presented the appearances found in early tuberculosis.

F. J. M., twenty-four years old.

Diagnosis.—Acute articular rheumatism, cardiac. Admitted to the Boston City Hospital December 2, 1898.

Family history negative. **Personal history:** Was in the hospital with acute articular rheumatism in June, 1898, for two weeks, and again in July and August, 1898, for four weeks. Lungs were then normal; temperature such as might be expected with rheumatism, not suggestive of tuberculosis. After discharge from the hospital in August his ankle continued to trouble him, but he kept at work until the middle of November. Then both ankles were painful, and the right wrist was also affected.

December 2, 1898. Says he has felt feverish and slept poorly on account of pain; no headache, no cough, appetite good.

Physical Examination.—Well-developed and well-nourished man, general condition good. Pulse 76. Lungs: Resonance and respiratory sounds normal.

December 17th. *X-ray examination*, in order to determine the size of the heart. Heart shows some enlargement both to right and left. Noticed while examining this organ that the right lung, from the apex as far as the third rib, was darker than normal, and the excursion of the diaphragm was diminished on this side, being $2\frac{1}{4}$ inches on the right side, and 3 inches on the left side.

On the same day the physical examination *after* x-ray examination showed that expiration was somewhat more marked in right apex in front. Tactile fremitus was slightly increased in right back between scapula and vertebral column. Patient, when asked if he had not lost in weight during past few months, thought that he had. Three attacks of rheumatism would account for this.

December 22d. One milligramme of tuberculin given. No reaction.

December 27th. Three milligrammes of tuberculin given. No reaction.

December 30th. Five milligrammes of tuberculin given; reaction well marked. Temperature 102.5°, with malaise.

December 30th. Morning and evening temperature for three weeks 98–99°. No cough at any time.

January 2, 1899. Prolonged expiration, slight increase in tactile fremitus in right back between scapula and spine, opposite spine of scapula.

January 2d. Discharged. His appearance at this time was that of a well man.

Physical examination of lungs as on December 17th.

In March, 1899, since this paper was read, the patient had another attack, and returned to the City Hospital. He was under Dr. V. Y. Bowditch's care.

Diagnosis.—Rheumatism. With Dr. Bowditch's permission I insert here the note he made of his physical examination of the lungs:

"Percussion note is slightly high in pitch, and slight dulness at right apex to third rib in front, and spine of scapula behind. No change in respiratory murmur and no râles. Resonance and respiration good over balance of chest."

In March, 1899, I made another *x-ray examination* and found the same darkened area of the lung and shortened excursion of the diaphragm as on December 17, 1898.

It is a serious matter for the patient to be told that he has trouble in his lungs, as well as for the family and friends, but it is much more serious if the physician fails to make an early diagnosis in pulmonary tuberculosis. The x-ray examinations assist us to do this in some cases and enable us to recognize the disease where, but for this method, it would be overlooked. I will say again, as I have said before, that a diagnosis of pulmonary tuberculosis is not made by the x-ray examinations alone, but with good apparatus and experience we can recognize early by its means certain departures from the normal in the lung. In many patients a correct estimate of the cause of the conditions present is difficult, as abnormality of the lungs may be due to other causes than tuberculosis, — convalescence from pneumonia, or sometimes from typhoid fever, for example, — and may disappear after a time. Two x-ray examinations should always be made, with an interval of some days at least between them. As in auscultation and percussion, experience is necessary to interpret the signs seen in the fluoroscope.

In an earlier paper I suggested that the increase in density of the lung, which makes a darker area on the screen, is not necessarily wholly an area of tuberculous lung, but may at first be largely due to the presence of congestion or serous exudation, as suggested by tests made in 1896.

A definite diagnosis is made by finding the bacilli, but this we cannot always succeed in doing. I recall, among others, a patient in whom pulmonary disease

was found while he was under my care for another serious disease, and from the earliest opportunity bacilli were sought for with the microscope. He died of tuberculosis; though more than twenty examinations were made, tubercle bacilli were never found. Again, in some of my patients, who proved later to have tuberculosis, an x-ray examination showed signs in the lungs before there was cough, that is, before expectoration could be obtained for microscopical examination.

I would point out that the x-ray examinations, besides aiding us to an early diagnosis, assist us to determine whether the disease is localized or disseminated, and how extensively the lung or lungs are involved, and help the physician to decide whether the patient should go away or remain at home. Also in acute tuberculosis we may be warned of the rapid progress of the disease by making two or three x-ray examinations at intervals of a week or two and thus recognize the serious character of the attack. We should expect to find an increase of temperature in such patients.

There are also cases in which, though the symptoms and physical signs indicated pulmonary tuberculosis, an x-ray examination showed normal lungs. This led me to state that these patients were probably not suffering from this disease, and the subsequent history or the tuberculin test indicated that the interpretation of the appearances on the fluorescent screen was correct. Many persons dread pulmonary tuberculosis, or fear they have it on account of the family history, or because they suffer from debility, or have had a persistent cough, or other symptoms which have aroused suspicion in their minds or in the minds of their physicians. To such individuals the assurance which careful x-ray examinations can give, in connection with other signs and symptoms, that the lungs are normal as seen by the fluoroscope is a great relief.

In another paper I called attention to the value of these examinations for life insurance; they can be made with little inconvenience, as it is not necessary to remove the clothing.

Dr. Abbott has pointed out that the Board of Health reports for the State of Massachusetts show that, out of 1,000 persons dying in this State between twenty and thirty years old, 597 die of tuberculosis of the lungs, that is, nearly 6 out of 10. The importance of careful x-ray examinations, especially among those between these ages and younger, will, I believe, be appreciated before long, particularly by people who may have any predisposition to the disease. As a precaution, we have our teeth examined once in a few months; the lungs are certainly as well worthy of careful oversight as the teeth.

To conclude: I do not advocate giving up any other methods for making an early diagnosis, — we need all the aids we can have, — but I do strongly urge the addition to them of careful x-ray examinations, and I desire to emphasize the value of this method as a means of indicating early certain abnormal conditions of the lungs. We have two methods of examining the heart and lungs — auscultation and percussion. Each of these in suitable cases gives valuable information; they require a trained ear and experience with many patients to make them serviceable. In some cases auscultation is of the greater value, in others percussion; more frequently they are best when used together. To these we may now add a third method, which also requires special training, that of x-ray examinations. There are diseases in which each of the

three methods may render the chief service, and each may in other cases be of little value. Usually, they should be used together: each supplements the other.

It seems well to repeat again, that even fear of burns in the use of x-ray examinations is unnecessary. I have made more than 2,000 of these examinations and no patient has received any burn or even inconvenience from them. Simple precautions, which may easily and should always be taken, prevent any risk even of injury.

FOREIGN BODIES IN THE LARYNX IN CHILDREN.¹

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FOREIGN bodies, as one would naturally expect, enter the air-passages in children much more frequently than in adults, the proportion being nearly two to one. Anything which causes a sudden strong inspiration, such as laughter, cough, fright or a blow on the back, while an object is in the mouth, favors its passage into the glottis. A foreign body entering the glottis may be arrested there or may pass on into the trachea or a bronchus. Objects are arrested in the larynx either because they are too large in one or more diameters to pass through it or because they have some peculiarity of shape or some prominent point or edge which causes them to be caught in one of the ventricles or to stick in the mucous membrane somewhere. Articles which most commonly enter the air-passages are bones, beans, fruit-stones, coins, needles, pins, seeds and grain. Smooth objects, like beans and fruit-stones, generally pass the larynx, while irregular objects, like pieces of bone, are more often arrested there. Coins are apt to remain in the larynx.

In a thorough and exhaustive article on foreign bodies in the air-passages Preobraschensky gives some valuable statistics, which I shall quote freely. He has collected 193 cases (adults and children) in which the foreign body was in the larynx, 105 in the trachea and 166 in the bronchi. His figures show that the mortality from foreign bodies in the air-passages up to 1866 (prelaryngoscopic period) was 41.2 per cent., while from 1866 to 1893 (when his paper was written) it was scarcely 30 per cent. Intralaryngeal removal was practised only once before 1866 and 54 times between that date and 1893; so that it seems fair to assume that the introduction of the laryngoscope is largely responsible for the improvement in the death-rate. The mortality of such accidents in children is less than in adults. Of 218 children operated on only 60 (27 per cent.) died, while of 63 adults operated on 30 (about 50 per cent.) died. Of 140 children treated without operation 64 (45 per cent. about) died, and of 136 adults without operation 69 (50 per cent.) died. Preobraschensky found the percentage of deaths in laryngeal cases somewhat larger (39.8 per cent.) than in tracheal cases (33 per cent.), but much smaller than in bronchial cases (55 per cent.). In some cases death comes so immediately on the entrance of the foreign body into the larynx that it must be due to shock (reflex paralysis of the respiratory centre following irritation of the laryngeal nerves). In other cases large objects may cause death quickly but not instantly, by mechanical obstruction of the object itself, or of

sudden edema of the larynx or trachea caused by its presence. Omitting these cases, which obviously would rarely be seen soon enough to admit of treatment, the mortality in laryngeal cases would be reduced to about 25 per cent. It should be borne in mind, moreover, in studying these figures, that a foreign body in the trachea is in constant danger of becoming impacted in a bronchus, thus falling at once into the most dangerous class of cases. If, therefore, we can prevent laryngeal cases from becoming either tracheal or bronchial by removing the foreign body *per vias naturales*, with the aid of the laryngoscope and suitable forceps, we shall obviously save more patients.

As intralaryngeal manipulation offers special difficulties in children, and as among them by far the largest number of cases occurs, it may not be unprofitable to study this class of cases more closely. Preobraschensky's tables show that in 39 cases of foreign body in the larynx in children in which laryngotomy or tracheotomy was done 13 died. On the other hand, in 13 cases the foreign body was removed from the larynx by instrumental means through the mouth, with 13 recoveries. He reports, further, 2 cases in which the foreign body was successfully removed by reversing the child, in one of which it was in the larynx; 6 cases of expulsion by means of emetics, with 1 death by suffocation, the object being arrested in the larynx; 65 cases cured by spontaneous discharge of the foreign body without medical aid, 7 of which were laryngeal, and 77 cases which died without medical treatment, 20 of which were laryngeal.

Since 1893 I have been able to collect from medical literature reports of 34 cases of foreign body in the air-passages of children, of which only 3 died (less than 10 per cent.) — a very low mortality. In 12 of these cases the foreign body was in the larynx, with 2 deaths. In 1 case death was immediate, from complete obstruction to respiration. In the other a shoe-nail had been in the larynx of a child ten months old for thirteen weeks, during which time the child had great difficulty in getting nourishment. After removal of the nail by tracheotomy the child died from inanition and probably broncho-pneumonia.

From the Massachusetts General Hospital records since 1872 I have collected 18 cases of foreign body in the air-passages in children, with 3 deaths. Four of these cases were classed as laryngeal, with no deaths. In none of these latter was it possible to remove the foreign body *per vias naturales*. Following are brief reports of these four cases:

CASE I. Service of Dr. Bigelow, November 24, 1884. An infant girl, age seven months, was thought to have a piece of apple stuck in her throat. The breathing became labored and stridulous. The mother, failing to get the piece of apple out, which she said she felt with her finger, pushed it down. Tracheotomy was done but nothing found. Laryngeal examination had been unsuccessful. Two weeks after discharge from the hospital the patient coughed up a thin but tough piece of apple-pip.

CASE II. Service of Dr. Cabot, August 12, 1885. A girl of nine years had a fragment of plum-stone in the larynx for two months, causing dyspnea and dysphonia. After tracheotomy the fragment was found just below the vocal cords, rather firmly embedded. It was about half the stone and had jagged edges. It would probably have been impossible to remove this object intralaryngeally, even had it been possible to

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