I. A bullet in the popliteal space. II. A case of dilated esophagus : two cases showing the value of the X-rays and at the same time that in the first case they were misleading / by W.W. Keen.

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I. A BULLET IN THE POPLITEAL SPACE. II. A CASE OF DILATED ESOPHAGUS.—TWO CASES SHOWING THE VALUE OF THE X-RAYS AND AT THE SAME TIME THAT IN THE FIRST CASE THEY WERE MISLEADING.

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Case 1.—W. G. S., 22 years of age, was admitted to the Jefferson Medical College Hospital October 30, 1899. On March 25, 1899, in a skirmish in Manila, a 45-caliber Remington ball passed through the right thigh, struck the inside of the left knee just above the line of the joint, and was buried in the tissues. Six weeks later he was able to be on crutches, but suffered a great deal of pain. Flexion was not limited, but the leg could not be extended to an angle of more than 45°, until lately, when the extension has somewhat increased.

The patient brought with him a skiagraph (Fig. 1) taken, August 18, 1899, by E. W. Ames, A. A. Surgeon U. S. Army, at the Presidio, San Francisco. This skiagraph shows the bullet very distinctly posterior to the head of the tibia. It is not, apparently, imbedded in the bone. A skiagraph taken by Mr. Prince in the Jefferson Hospital, on his admission, confirmed this finding. Dr. Sweet, who located the ball exactly by this skiagraph, has kindly furnished me with the following description of the application of his localizing apparatus and, as will be seen, his location of the bullet was exact both as to position and depth.

The essential features of this apparatus and the method of employing it are shown in the illustration, Fig. 2.[1] An

[1] From DaCosta's "Manual of Surgery."

adjustable arm carries two ball-pointed rods which are at a known distance apart, and are parallel with each other and with the photographic plate, while the balls are perpendicular to each other and the plate.

When the skiagraphs are made, one of the indicator-balls rests against the skin at any point in the neighborhood of the foreign body, while the second indicator is toward the plate. The spot on the skin at which one of the indicator-balls rests is marked with silver nitrate, as the position of the foreign body is measured from this point.

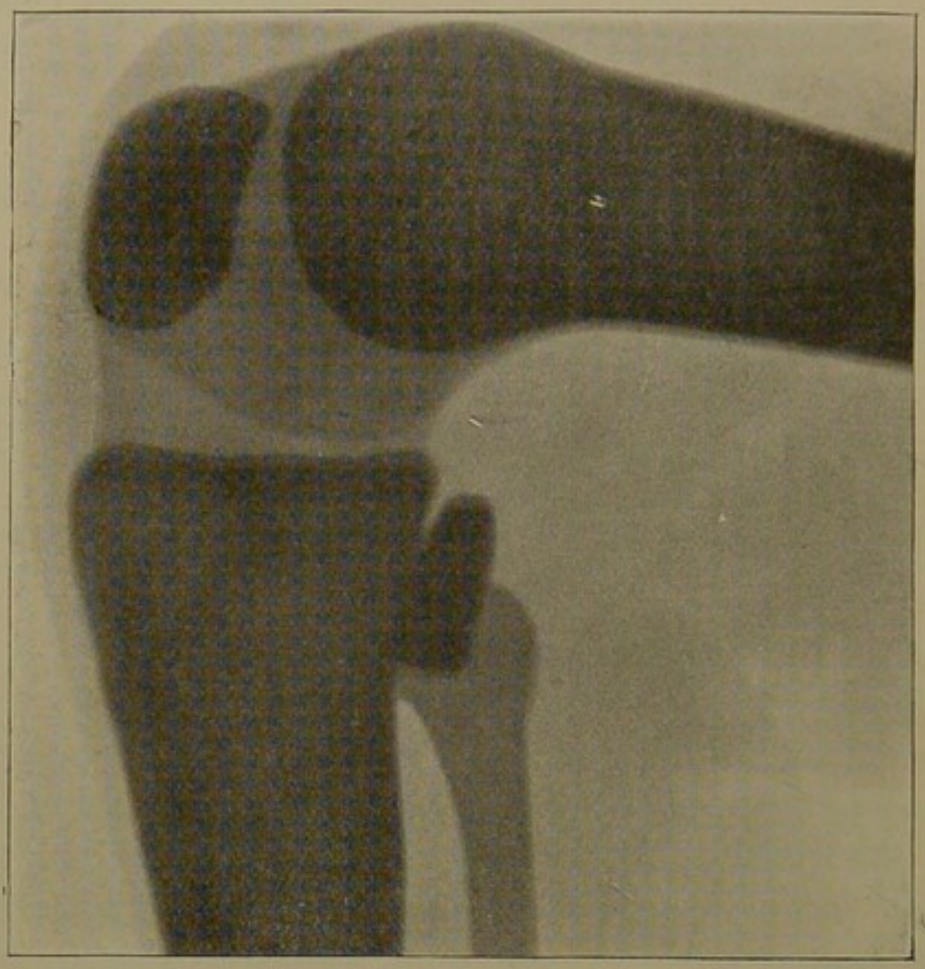

FIG. 1.—Skiagraph by Dr. Ames showing the bullet *in situ*.

Two skiagraphs are made to give different relations of the shadows of the two indicators and the bullet, one exposure with the tube horizontal, or nearly so, with the plane of the indicators, and a second exposure with the tube at any distance above or below this plane. Since the shadow of the foreign body preserves at all times a fixed relation with respect to the shadows of the two indicator-balls in whatever position the tube is placed, and since the situation of two balls is known, the location of the foreign body in the

tissues is readily determined from a study of the planes of shadow at the two exposures.

When the skiagraphs of the case here reported were made, the anterior surface of the leg was placed upon the bottom of the right angle support of the apparatus, the plate to the inner side of the knee, one indicator-ball resting on the skin nearly in the center of the popliteal space. The skiagraph made with the tube horizontal with the plane of the indicators is shown in Fig. 3, and the second skiagraph with the

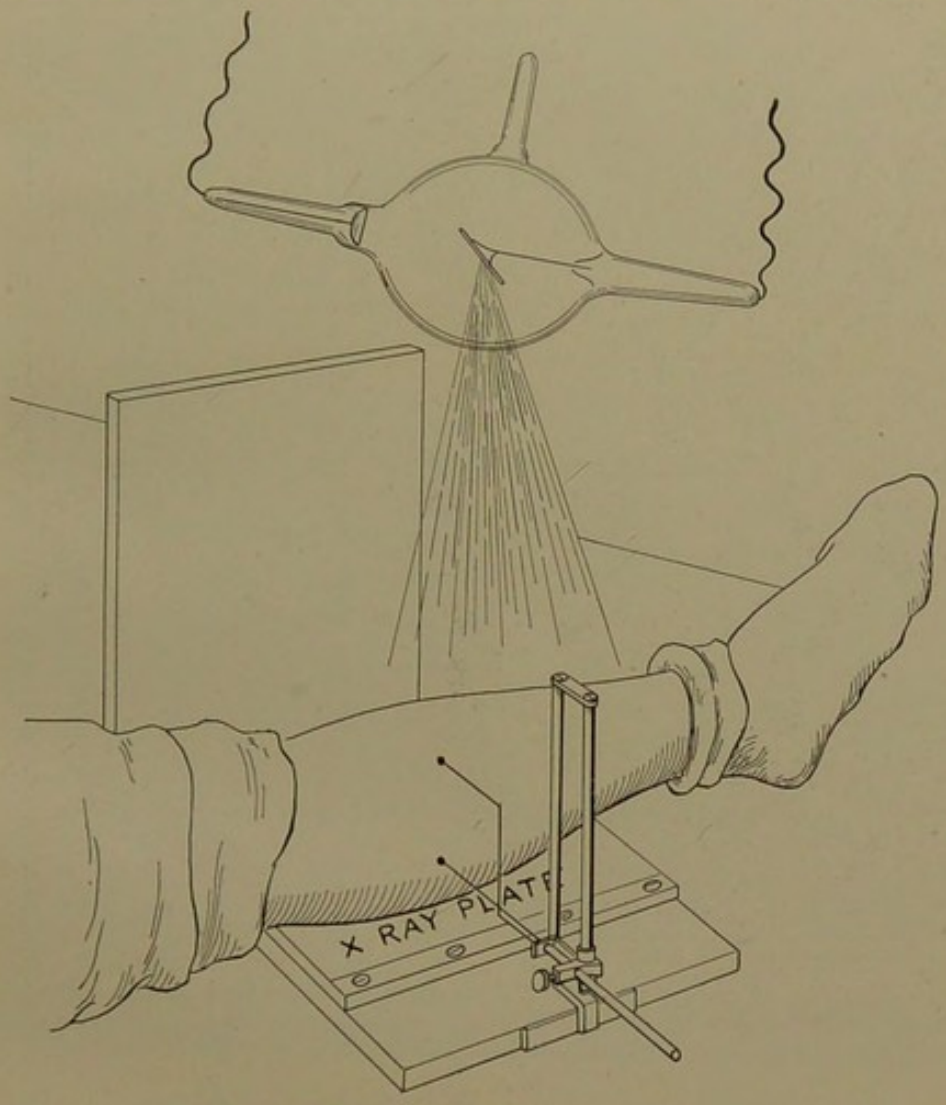

FIG. 2.—Dr. Sweet's localization apparatus.

tube a short distance above the first position is seen in Fig. 4. Both negatives show the leg as viewed from the outer side, with the posterior surface of the leg uppermost.

In determining the position of the bullet a spot is made upon paper to indicate the point on the skin at which one of the indicator-balls rested at the time of the exposures, a second spot being made 2 inches from the first, to represent the fixed distance between the two balls. These are shown

at *A* and *B*, upper diagram, Fig. 5. The first negative is now taken. The distance the shadow of the bullet is below the shadow of each of the two indicators is measured and this distance entered below the spots representing the two balls when the exposure was made. (*C* and *D*.) A line drawn through these points indicates the plane of shadow of the bullet when the first skiagraph was made. Similar measurements are made from the second negative and marked below the spots *A* and *B*,

A

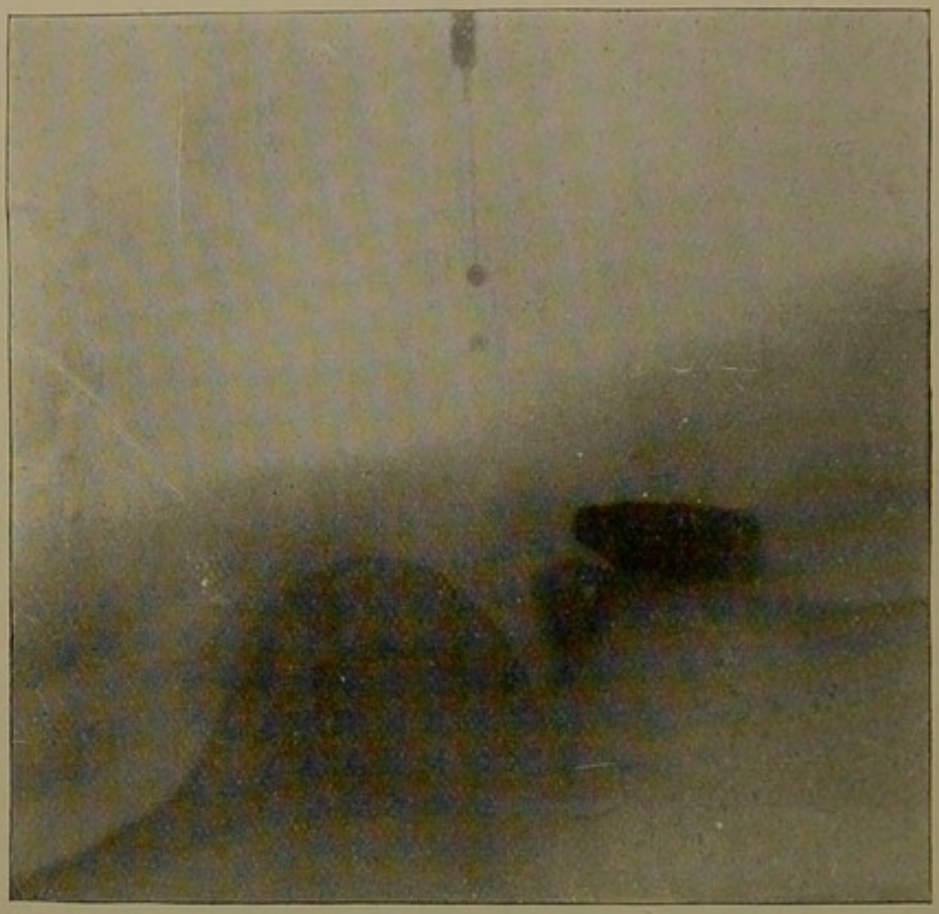

FIG. 3.—Method of using Dr. Sweet's apparatus. Skiagraph made with tube horizontal to plane of indicators. The bullet is well seen. Opposite *A* are seen the two balls at the ends of the rods.

the line through the spots (*F* and *H*) giving the plane of shadow when the second negative was made. Where these two planes of shadow cross (*X*) is the position of the bullet as measured below and to the inner side of the nitrate of silver spot on the skin.

In determining the depth of the bullet in the tissues, a second diagram is made to indicate the position of the two balls, as viewed from a cross-section of the leg. Since the tube was only 24 inches away at the time of the exposure, the convergence of the rays in an object as large as the leg must

be allowed for. This is done by measuring the distance the shadow of one ball is behind that of the other, entering this distance (*A K*) on the diagram, and marking on a line through this point, 24 inches from the ball resting on the skin, the situation of the tube. If we now measure the distance the shadow of the bullet on the first negative is back of that of the shadow of the ball on the skin, enter this distance in the plane of this indicator (*B M*), and draw a line from the situation of the tube through this point, we obtain the plane of the shadow of the bullet when the exposure was made. Drawing a line from the position of the bullet as previously

A *B*

FIG. 4.—Method of using Dr. Sweet's apparatus. Skiagraph made with tube above horizontal plane of indicators. The bullet is well shown. Opposite *A* and *B* are seen the two balls at the ends of the rods.

found on the first diagram, the intersection of this line with the plane of shadow upon the second diagram gives the situation of the bullet from a cross-section view of the leg. For purposes of greater clearness, outlines of the leg have been shown in the two diagrams, although this is unnecessary in practice, since the position of the foreign body in respect to a known point upon the integument is all that is required. The position of the bullet was shown to be 1 inch

toward the inner side of the spot on the skin at which one of the indicator-balls rested, 1¼ inches below this spot, toward the ankle, and imbedded in the tissues to the depth of 1½ inches. Both skiagraphs show the bullet close to the bone, but, owing to the false projection, so common in all x-ray pictures, it is impossible to say whether the bullet was imbedded in the bone or not.

Nothing seemed easier than to cut down at a point so exactly indicated and, by introducing the finger, to detect the bullet at once and remove it with ease. On November 1 in the clinic I proceeded to operate. An incision four inches long was made over the spot indicated, but on introducing my finger no trace of such a projectile could be found on the posterior surface of the tibia. I cut down to the bone itself at 3 adjacent points and by means of retractors was able to look at its posterior surface very clearly, but no bullet was to be seen. I then explored the posterior surface of the tibia, passing my finger between the popliteal vessels and the bone, all the way to the external border of the tibia and still could not find it. After considerable search I again returned to the original place as shown in the skiagraph. The bone was covered at this point by the fibrous insertion of the semimembranous muscle. After incising this I finally came upon the ball *imbedded below the surface of the bone.* With a great deal of difficulty I was able to pry out and remove it. I then found a deep cavity in the bone, the edges of which were so sharp that I gnawed them away with the rongeur forceps. After washing out the wound with salt-solution I closed it by interrupted sutures and placed the leg on a posterior splint. His temperature only once reached 99°. Twelve days after the operation he left the hospital with the wound entirely healed.

Dr. Ames, through whose courtesy I am able to reproduce the picture, in a letter to me states that he made a fluoroscopic examination and that both that and the *x*-ray picture apparently showed the bullet in contact

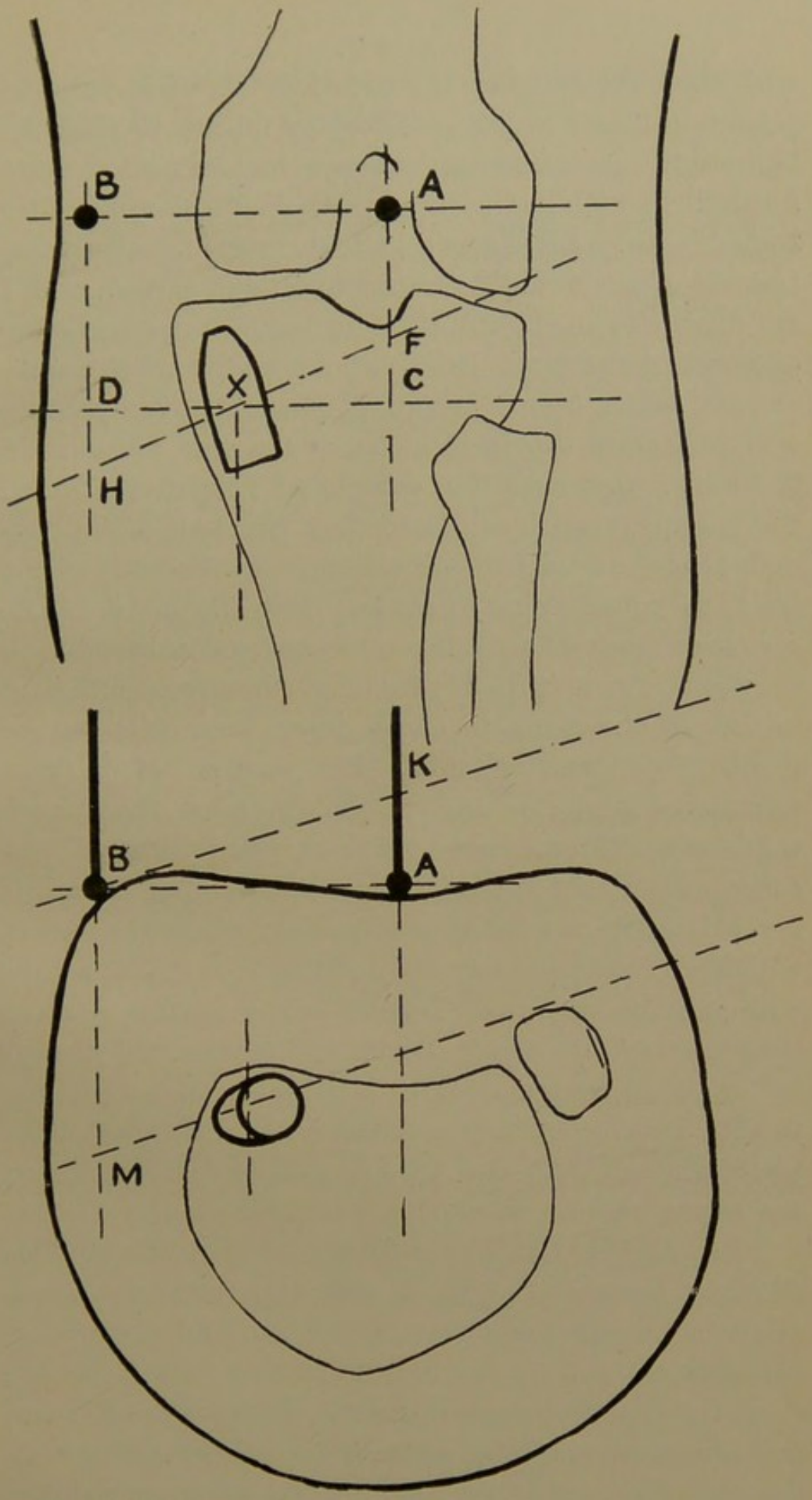

FIG. 5.—Method of indicating location of bullet. Upper diagram, posterior view of leg from above. Lower diagram, cross-section of leg, near knee-joint.

with the tibia and not imbedded in it. The only explanation that I could give for my failure to find the ball readily was that its presence had caused a bony formation which had covered the ball and so apparently imbedded it. Dr. Ames says that "recent bone-formation does not make a shadow upon the screen, and I am unable to say how old the formation must be before obstructing the ray. Brief exposure will show a provisional callus upon a negative, when an overexposure will obliterate the impression of the new formation." He adds: "After reading your letter I again examined the picture and I conclude that the ball is imbedded about an eighth of an inch in the wall of the tibia instead of being in contact with the bone. [The operation showed that the *entire ball* was embedded in the bone. W. W. K.] If this be so there was sufficient injury to the bone to cause new bone cells to be thrown out, and I think the surface of a new formation might be smooth and in more than seven months could become as hard as you indicated. Another point that I should have stated is that a 'mild' ray will show a new bone-formation upon the screen which will not be shown by an intense ray, *i. e.*, a tube with a high vacuum. I have to my sorrow learned that the ray has many tricks and we cannot always believe what we see, or rather fail to see, and a picture, to tell the truth, must have the plate, the object to be photographed, and the tube in proper relation during the exposure."

This case is, I think, particularly valuable both as showing, by means of Dr. Sweet's apparatus, how accurately a foreign body can be located, and again how cautious we should be in interpreting what is apparently a perfectly plain case. We have yet to learn the errors into which we may be led by the x-rays, especially in cases in which medico-legal proceedings

may be instituted and very unwise inferences drawn from what looks like a perfectly clear case.

Case 2.—A. D. S., 31 years of age, entered the Jefferson Medical College Hospital October 19, 1899, at the instance of Dr. Reynolds, of Reynoldsville, Pa. Nothing of importance is elicited by his family or personal history until September 23, 1893. While lifting a heavy weight of coal he was suddenly seized with sharp pain in the epigastrium and beneath the lower and of the sternum. The pain was so severe that he had to quit work. The following day he felt a tickling sensation low down in his throat which caused violent coughing. In a few minutes he began to expectorate blood. In the evening he vomited what he describes as pure blood. The following day the vomiting occurred again, when about 3 pints of blood were lost. For the next three days he was very sore across the abdomen and was not able to return to his work for a period of nearly 5 months. In December, 1894, he began to experience a sensation as if his food stopped somewhere in the esophagus. In order completely to swallow an ordinary meal he was obliged to drink about a pint of water. As a rule, this water was at once vomited.

On admission, I found that when he drank about a pint of water sudden and increasing dyspnea set in until finally he was scarcely able to breathe. At the same time the veins in his neck became exceedingly prominent, the superficial veins when distended being nearly as large as the fore-finger; the entire neck and face became deeply congested and in violent attacks it seemed almost as though he would choke to death. On the right side of the neck in the region of the lower end of the sterno-cleido-mastoid there was noticed a distinct swelling which extended nearly up to the cricoid. The neck on the right side was much more firm and resistant than on the left. By an effort he was able immediately to regurgitate the fluid, when all these phenomena of swelling, dyspnea and congestion disappeared. A stomach-tube was introduced many times into his stomach and never met with the slightest obstacle. The following experiment was then tried repeatedly and always with the same result. Through the stomach-tube from half a pint to a pint of milk was introduced into the stomach. The stomach-tube was then removed and he drank a pint of clear water. This water he readily regurgitated entirely unmixed with any milk. The amount of water regurgitated was somewhat less than the amount which had been swallowed.

When he entered the hospital it was with a diagnosis of a diverticulum of the esophagus. I made repeated attempts by means of the finger, esophageal probangs,

catheters coudés, bent probes, etc., to find the mouth of any diverticulum, but was never successful in finding it. Professors Hearn and DaCosta, of the Hospital, Dr. Mayo, of Rochester, Minn., and Dr. Ochsner of Chicago, Ill., who were visitors at the time, made similar attempts and were similarly unsuccessful.

Dr. S. J. McGhee, to whose very intelligent care and interest I owe very much, on different occasions introduced the stomach-tube 10, 15, 20 cm. and so on, increasing the depth of its introduction each time by 5 cm. until 50 cm. of the tube was introduced. A measured quantity of water was then poured down the tube and the same amount of water was regurgitated. At 55 cm. no regurgitation took place.

In order to determine the possible existence of a diverticulum the patient was skiagraphed by Prof. A. W. Goodspeed on several occasions. Instead of swallowing plain water, a mucilaginous mixture in which were suspended from 4 to 6 drams of bismuth was swallowed and a skiagraph taken immediately. Unfortunately the dyspnea and other urgent symptoms prevented his retaining the bismuth a sufficient time to make any prolonged exposure to the *x*-ray. I was very desirous of tracing the esophagus at the same time. The rubber stomach-tube was found to be transparent to the *x*-rays, as also was the whalebone handle of an esophageal probang. Upon the suggestion of Messrs. Queen & Co., of this city, Dr. McGhee wound a copper wire spirally around a brass rod of the diameter of a lead pencil. On introducing this long spiral of copper wire into a rubber tube, but without allowing the end of the wire to project beyond the end of the tube, we had a protected flexible bougie of metal which would be impermeable to the *x*-rays. On another occasion, following the suggestion of Dr. C. L. Leonard, a number of large perforated shot were strung securely on a silk string

and this was passed down into the esophagus. The pictures of the neck and chest were not quite as satisfactory as could be desired, in consequence of the short exposure, but certain things were perfectly well seen. In one picture (Fig. 6) the covered spiral wire was dis-

FIG. 6.—Spiral wire in esophagus. (Skiagraphed by Prof. A. W. Goodspeed.)

tinctly to the right of the median line of the chest. On the contrary, the string of shot (Fig. 7) showed distinctly to the left of the median line. This might be due either to displacement of the esophagus to right or

left by pressure, or by the weight of the foreign body, or it might be due to a dilatation of the esophagus which allowed such a foreign body to be displaced to the right or the left of the median line. The dark area in the middle of the skiagraph, when the bismuth was introduced, was certainly larger and, especially, wider than in a normal chest. This was partially due to the shadow of the heart. A fluoroscopic examination was then made, not from before backward through the sternum and vertebræ, but from side to side, when only the ribs would obstruct the rays. The perforated shot on the silk string were then introduced, and the shot could be seen by the fluoroscope piled up just above the opening in the diaphragm.

While there have been some few cases of a diverticulum of the esophagus observed in its thoracic portion, this is extremely rare. Diverticulums almost always open from the cervical portion of the esophagus and more commonly on the left side. The swelling on the right side and the obstruction to breathing and to the return of the blood-current seemed very much in favor of a diverticulum. This would produce the swelling in the lower right neck, would possibly either displace or press upon the trachea sufficiently to produce the dyspnea, and if it reached the thoracic cavity might press on either the superior vena cava or the two innominate veins which unite to form the cava and so account for all these phenomena.

The absence of any obstacle to the introduction of the stomach-tube seemed also to favor the idea that the water retained entirely apart from the milk in the stomach must be in a diverticulum, though the amount of water (a pint) was more than could be retained in any diverticulum with which I was acquainted. On the other hand it would be possible for a very much dilated esophagus to hold a pint of fluid, and if water

reached the level of the upper portion of the esophagus it might produce all the phenomena which have been related.

In order to determine with absolute certainty whether or not there was any diverticulum, on Novem-

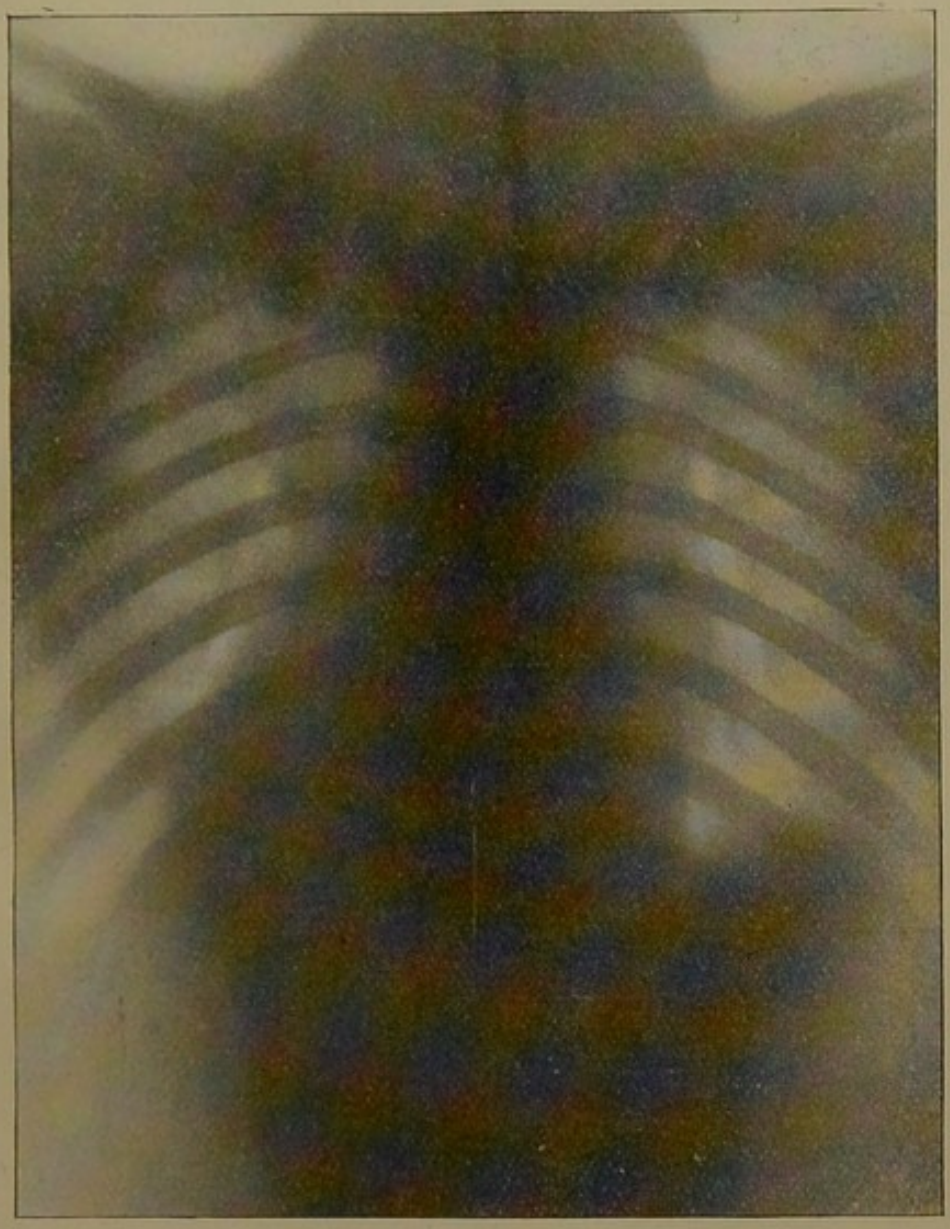

FIG. 7.—String or shot in the esophagus. (Skiagraphed by Prof. A. W. Goodspeed.)

ber 22, 1899, I explored the neck by a long incision at the anterior border of the sterno-cleido-mastoid. I avoided the vessels, found the esophagus and the trachea and the recurrent laryngeal nerve, introduced

by the mouth, an esophageal probang, the bulb of which was most plainly seen and felt in the wound, but no diverticulum could be found. The wound was then closed and the patient made an uninterrupted recovery, the wound being entirely well within a week. For two days he was scarcely able to swallow anything on account of the soreness of the esophagus, but on the third, fourth, and fifth days after the operation he was able to swallow with perfect ease. On the sixth day he again experienced difficulty in swallowing and this has continued to some extent, though by no means so marked as formerly, up to the present date, December 7, when he was transferred to Professor Dercum's care in the nervous ward.

My final diagnosis was that he had a nervous spasm of the esophagus just above where it passes through the diaphragm, and that all of the phenomena were to be accounted for upon this basis. Professor Dercum was not able to find the stigmata or the reversal of color fields, which so often accompany hysterical cases.