Westbrook (B. F.)

ON ABSTRACTION OF BLOOD FROM THE RIGHT HEART,

As a Means of Relieving Intense Pulmonary Congestion

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ON ABSTRACTION OF BLOOD FROM THE RIGHT HEART,

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About a year ago, while engaged in the demonstration of the anatomy of the thoracic viscera, it occurred to me that, in a case of very acute and intense pulmonary congestion, with over-distention of the right side of the heart, it would be practicable to withdraw a quantity of blood directly from the heart, and so restore the equilibrium of the lesser circulation.

In order to have some exact anatomical data for the discussion of the question of the accessibility of the organ, and the determination of the proper point for puncture, I have made, during the year, a series of dissections of bodies of those who have died of various diseases. Though my observations are not yet sufficiently numerous to justify their publication, they have been carried far enough to enable me to describe a mode of procedure which may safely be undertaken by any one who is competent to make an ordinary physical exploration of the chest.

The *right auricle* is the most available point for tapping, inasmuch as its position is less variable than that of the ventricle, and its accessible portion more globular, with a greater antero-posterior diameter to allow of free penetration of an instrument without danger of its passing through into the posterior wall. As an additional advantage, the walls are thinner than those of the ventricle, and not beset by the projecting fleshy columns and papillary muscles which exist in the latter.

In order to determine the best point for puncture, I have measured the extent to which the auricle projects beyond the right

border of the sternum in the different intercostal spaces, its perpendicular depth from the anterior face of the sternum at its right edge, the amount of overlapping of the anterior border of the right lung, and the course of the internal mammary artery and vein. The variation in regard to all these points, except the last, is very considerable in different subjects, and under different conditions of circulation and of the respiratory organs; but I am, nevertheless, enabled to state, with a considerable degree of certainty, the following propositions:

First.—The right auricle projects to the right about equally in the third and fourth intercostal spaces.

Second.—Its perpendicular depth varies greatly, according to its distension and the condition of the left heart and lungs.

Third.—The projection to the right is greatest, and the perpendicular depth least, when the right heart is distended, as in death from coma and asphyxia.

Fourth.—The internal mammary vein, which lies upon the sternal side of the artery, is very constant in its course, and situated, on an average, about one centimetre external to the right border of the sternum.

Fifth.—The anterior border of the right lung almost always extends inwards beyond the border of the sternum, reaching, or even passing the median line in many subjects.[1]

An instrument inserted into either the third or fourth intercostal space, at the right edge of the sternum, and carried directly backward in a plane parallel to the median plane of the body, will, after piercing both layers of the pleura and the lung, enter the pericardium and penetrate into the right auricle. This would occur in almost any thorax when the heart was not displaced by pressure from pleuritic effusion, contraction of the lung, or other similar conditions. I say *almost any*, because, in one case of marked emphysema, with a depressed diaphragm,[2] the upper limit of the auricle was at the middle of the third interspace.

The conditions alluded to as displacing the heart are all readily diagnosticated by those skilled in auscultation and percussion.

The third interspace is better suited for the puncture, for two reasons: first, because it is much wider than the fourth, and the

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1 While these propositions are based upon actual dissections, I claim no originality for them, as they are mainly confirmatory of the observations of other anatomists, though no one, as far as I know, has investigated the subject from the same standpoint.

2 The term *depressed* diaphragm is partly relative; the change of position is largely due to elevation of the ribs.

needle passes with less difficulty; second, because the line of the fourth would direct the needle more toward the auriculo-ventricular opening, where it might come in contact with the tricuspid valve. The necessity for going directly backward, in a line parallel to the median plane, will appear further on.

The pressure in the right auricle, in cases of considerable obstruction, though it *departs* from the normal negative standard, does not rise sufficiently to be relied upon to force blood out through a small canula with any degree of rapidity, hence it is necessary in introducing a tube, to have it connected with a vacum chamber—in other words, it is necessary to operate by means of aspiration.

When these points were satisfactorily settled, a further question arose, as to the danger of leakage occurring from the orifice of puncture.

This was deemed improbable, on the ground of experimentation, and of comparison with the results of puncture of other hollow viscera. As I was anxious, however, to avoid every possible risk of increasing the peril of any patient, I chose for the subject of the operation, which I am about to describe, a case in which all chance of recovery had disappeared.

The patient was a German, fifty years of age, the father of a family of healthy children. He had always been strong, though not plethoric, was very temperate in his habits, and had not been sick for twenty years. On November 10th he had a slight chill, followed by fever and severe lancinating pain in the right side. He sent for the family physician, Dr. Paul H. Kretzchmar, who attended upon him, and from the above symptoms, and a loud friction sound, diagnosticated an acute pleurisy in the lower portion of the right chest. On the following day the rusty sputa of pneumonia appeared, and, on auscultation, bronchial respiration was found in the upper portion of the right lung. But, though the apex was the seat of the most active pneumonic inflammation, the pulse was full and bounding, the delirium active, and the fever of the sthenic order. As hepatization occurred, the fever did not abate, but the disease steadily advanced. The rusty sputa continued to be quite copious until the 15th, when they diminished materially, and the cough became less frequent and less effectual.

On the 15th, Dr. Kretzschmar requested me to see the patient with him, as he had become alarmed by the persistence of the severe symptoms, as well as by the fact that the respiratory murmur upon the left side was becoming rough with an occasional moist râle. On the

morning of the 14th, the temperature had been at 102° F., the pulse 132 per minute. In the evening, the temperature had risen to 104°, pulse 140, and respiration 28. On the morning of the 15th, the temperature was 101½°, pulse 134, respiration 27.

At 6 o'clock P. M., when I first saw him, the record was: temperature, 103¼; pulse, 140; respiration, 28. The breathing was very labored, and loud, mucous râles could be heard from any part of the room. The countenance was anxious and the mind wandering. The pulse was of fair strength and regular. On examination of the chest, we found dullness on percussion over the entire *right* side anteriorly and laterally, most marked above the fourth rib. Typical bronchial respiration extended from the clavicle to the third interspace, while, below, there was a mixture of large and small moist râles and friction sounds. The *left* side presented the usual evidences of compensatory respiration, viz., increased resonance and exaggeration of the vesicular murmur, together with some roughening in places, and a few moist râles. The cardiac impulse was strong, the epigastric pulsation well marked, and the distention of the right side so considerable that its movements could be felt in the third and fourth right intercostal spaces. The second sound over the pulmonic area was very much accentuated.

As the patient was a man of vigorous frame, bearing the struggle well, as shown by the force of the heart and the slowness of the labored respirations, we concluded that, though very serious, his condition was not hopeless, and endeavored by stimulation, nourishment and counter-irritation to help him to recover the equilibrium of his circulation. He was ordered the following mixture:

R.	Ammon. carb.....	℈ ij.
	Tr. digit.....	*m* xlviij.
	Tr. opii.....	*m* xij.
	Tr. nuc. vom.....	*m* xvj.
	Aqua menth. pip.....	℥ j.

Sig.—One teaspoonful every hour.

He was also to have a tablespoonful of brandy every hour.

On the following morning, at 9:30 o'clock, we found him in much the same condition, only a little weaker; temperature, 100¾°; pulse, 128; respiration, 36. The temperature and pulse had fallen somewhat, but the respirations were more rapid and noisy. He coughed but little, and expectorated a little tough bloody mucus. However, as the heart retained its strength and the temperature was

lower, we still had a slight hope, and continued his treatment with the addition of a little more alcoholic stimulant.[1]

At 2 o'clock P. M. I saw the case in Dr. Kretzschmar's absence. He had lost perceptibly since morning. The temperature was 101½°, pulse 140, respiration 45, and very labored. Moist râles were increasing upon the left side, and the breathing was harsh and indicative of considerable bronchial congestion. His pulse was still remarkably strong, but quick and nervous, with an occasional intermission. The respiratory muscles kept at their task with remarkable vigor, but the struggle was evidently hopeless. It was plain that there was no longer any chance of recovery, nevertheless I hesitated to attempt any operation in the absence of the physician in charge, though Dr. Kretzschmar had signified his desire that I should do whatever seemed best. Accordingly I ordered ten drops of digitalis to be given every hour in addition to his other medication. On my return at 6:30 o'clock, the pulse had risen to 150, respiration 40, and there was no sign of improvement.

After consultation with my friend and assistant, Dr. Emilio Buchaca, who accompanied me, I proceeded to attempt the aspiration of blood from the right auricle with a view to unload a part of the burden under which the heart was staggering. We used for the purpose one of Codman's aspirators, manufactured by Geo. Tiemann & Co., selecting the finest needle, which was about twice the calibre of an ordinary hypodermic needle (.75 mm.). The instrument worked well, and a good vacuum was secured. The needle was then warmed over the chimney of a student lamp, and passed through the third intercostal space, close to the edge of the sternum, to the depth of about five centimetres, when it communicated to the hand the sensation of being in the auricle.

The sensation referred to is that familiar to every surgeon, by which we know that the point of the instrument has passed into a cavity or fluid; with the addition of the motion of the auricle, which causes the needle to move slightly to and fro with the pulsations of the heart. The stop-cock connecting with the vacuum was then turned, but only a few drops of blood fell into the bottle. Thinking that I might be mistaken as to the whereabouts of the needle, I passed it a little farther, when it entered a hard substance that felt somewhat like soft spongy bone, or calcareous matter, and its point began a series of such active movements that it was evident

[1] The brandy ordered the night before had not been regularly administered.

that it had punctured the aorta. It was withdrawn a little way and replaced in the auricle; but, though the suction was increased by more pumping, only about a drachm of blood was abstracted, and finally, not daring to leave the needle longer in the heart, for fear of coagulation upon it, I discontinued the operation. The introduction of the needle, which was very sharp, occasioned no more pain than does that of the hypodermic syringe, and its entrance into the heart was accompanied by no unpleasant symptoms; indeed, the heart's action did not seem to be affected at all. When the aorta was punctured the patient complained of a feeling of distress in the sternal region, and remarked that he thought I had struck a bone.

The failure of the operation was due to two causes: first, in order that the needle should impinge as squarely as possible upon the convex auricle, I directed the point a little inward, which caused it to penetrate at the base of the auricular appendix, and, when more deeply inserted, to perforate the latter and strike the outer side of the aorta. The second cause of failure was that the needle selected was too small, and the blood could not be delivered very rapidly through it, so that it coagulated in the rubber tube above.

I hesitated to repeat the operation at once, but preferred to wait a sufficiently long time to see if the first attempt was to be followed by any bad effects. After waiting half an hour, and observing none, I took my departure, promising to return later in the evening. At 7 o'clock, Dr. Kretzschmar called and found the patient much as I had left him; pulse, 150; respiration, 40. There were no sensations referable to the puncture. At 10:45 P. M. we saw him together. The pulse was 144, respiration 44. We determined to make another attempt at local bleeding, as a *dernier ressort*. I selected a needle, the outside diameter of which was 1.5 mm. This was thoroughly cleaned, heated over the lamp chimney, and introduced through the third intercostal space, directly backward, till, at a depth of about 5 cm., it was free in the cavity of the auricle. The cock was then turned and the blood ran freely into the bottle. No pain or distress was experienced during the operation. After abstracting a little over three ounces of blood, I withdrew the needle. It was followed by a few drops of very dark venous blood. A towel was applied to the spot for a moment, after which there was no further oozing. Five minutes after the operation the pulse was 150; respiration, 40. At the end of half an hour the pulse was 148; respiration, 40. The character of the pulse, however, was somewhat changed; instead of the quick, hard, nervous beat, it was softer and

less irritable; there was no intermittence. When asked how he felt, he simply said, "I feel better." We then ordered him the following prescription, and withdrew:

R. Ammon. carb..... ℥ iss.
Tr. digitalis..... ℥ iiss.
Tr. nucis vom..... ℥ ss.
Tr. opii..... *m* xxiv.
Spts. vini rect..... ℨ iii.
Tr. cardam. co..... ℥ iiss.
Syr. pruni virg.....ad. ℨ vi.

M. Sig.—One tablespoonful, in water, every hour.

Dr. Kretzschmar saw him at seven o'clock on the following morning. The friends said that he had been more comfortable during the night than for the three or four days previously, so much so that they had begun to entertain hopes of his recovery. Dr. Kretzschmar, however, was unable to confirm their hopes, for, on auscultation, he found numerous moist râles in the left lung, which was becoming œdematons. The pulse at this time was 138, and the respiration 38 per minute.

He remained in about the same condition until half-past ten, when he suddenly became restless, rolled over to the back of the bed, rose up on his elbow, and fell back dead.

The autopsy was made on the following day, thirty hours after death. On examination, two minute spots, indicating the points of puncture, were found in the skin at the side of the sternum, in the third interspace. The deeper layers of the skin, superficial fascia and pectoralis major were infiltrated with blood in a district one-fourth of an inch in diameter.

The costly and visceral pleuras, three-fourths of an inch from the anterior border, also bore a slight blood-stain about one-half an inch by three-fourths of an inch. The slight hæmorrhage had come from a small branch of the internal mammary vein, which ran inward toward the sternum (perforating branch). On the posterior surface of the edge of the lung there was a slight roughness at a point corresponding to the mark of puncture on the anterior surface, but no distinct trace of the passage of the needle could be discerned. Immediately below this point, on the mediastinal pleura were two minute red dots, one about one centimetre nearer the median line than the other. These dots were about five millimetres in diameter, but the inner one was a little the larger. The inner surface of the

parietal paricardium presented two dots corresponding to those just described. On the auricle it was impossible to identify the site of penetration, unless by comparison with the spots on the pericardium; except that, corresponding to the innermost spot, there was a very indistinct roughness of the surface, as if from a slight scratch. This was at the base of the auricular appendix. Drawing the appendix outward, I found in the outer side of the aorta, near its base, a round, dark-red mark, three milimetres in circumference, in the adventitia. This was, no doubt, the place where the needle struck the aorta after piercing the auricle. No corresponding mark could be found on the inner coat. The pericardium contained from three to four fluid ounces of thin serous fluid of a dark claret color. It was not distended, as its anterior portion lay in contact with the right ventricle. Along the inferior border of the heart lay a filament of coagulated fibrin one and one-half inch long and very narrow. Its color was a pinkish white. A thin, membraniform, pinkish white coagulum was spread out upon the anterior surface of the right auricle, in its lower and internal half, extending into the auriculo-ventricular groove, where it became thicker and darker. The whole amount of coagulum might have represented two or three drachms of blood, at a very liberal estimate, but my impression is that some of it was due to inflammation, for the right side of the pericardium adjacent to the inflamed pleura showed some thickening. We were, however, unable to make any microscopical examination of the fluid, owing to the difficulties attending the getting and making of the autopsy. All the cavities of the heart were distended with black clots, which occupied the venæ cavæ, pulmonary veins and artery, and aorta. In the right ventricle we found a small, whitish coagulum clinging to the columnæ carneæ, but not extending into either the auricle or pulmonary artery.

The upper lobe of the right lung was passing into the stage of gray hepatization. The pleura, over the entire surface, was very red, and thick, tough masses of coagulated lymph covered its surface below the second rib. The base of the lung was almost black, partially collapsed at the periphery, and covered by thick curdy masses, such as are found in the most acute and pronounced pleuritis. This condition also extended to the mediastinal pleura. There was very little fluid in the pleural sack. The left lung was universally adherent from an old pleurisy. It was dark, and oozed black blood upon section. The bronchi contained a good deal of frothy muco-pus, slightly tinged with blood.

The important points established by this operation are: in the first place, that the right auricle may be readily aspirated, and, secondly, that the introduction of a canula into its interior is not accompanied by any alarming symptoms, or followed by any unhappy results. I am convinced that, had the operation been done earlier, say on the 14th or even on the 15th, and had a larger quantity of blood been removed, the prospects of recovery would have been greatly enhanced. But, as already remarked, I did not feel justified in making the first attempt upon any one who had the slightest chance of recovery. The reason for withdrawing the needle before a larger quantity of blood was abstracted was that, although it would be perfectly safe to leave the instrument in the heart of a healthy animal for a much longer time, I was not sure that the blood of the pneumonic subject would not coagulate upon the needle: but, at another time, I should not hesitate to leave it long enough to withdraw at least eight or ten ounces.

The length of time the needle remained in the heart was not ascertained, but it was probably not over half a minute.

The slight amount of leakage that occurred was undoubtedly caused by the first puncture, when the needle was moved to and fro by the pulsations of the aorta, and allowed of oozing by its side. At the second trial the needle was held firmly in one place, and I do not think there was any leakage.