

**Intra-thoracic surgery : bronchotomy through the chest-wall for foreign bodies impacted in the bronchi / by De Forest Willard.**

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# INTRA-THORACIC SURGERY:

BRONCHOTOMY THROUGH THE CHEST-WALL  
FOR FOREIGN BODIES IMPACTED IN  
THE BRONCHI.

BY

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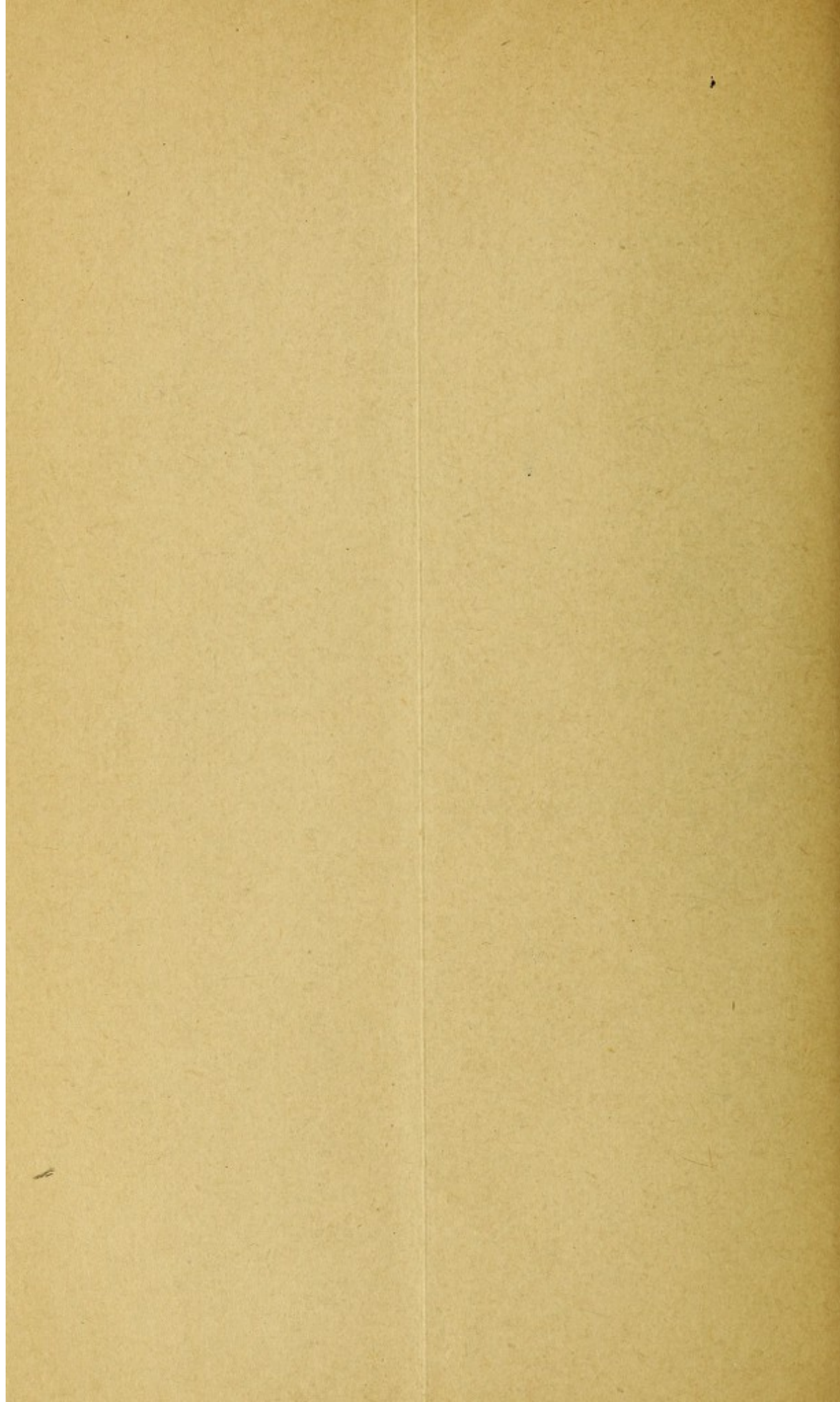
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## INTRA-THORACIC SURGERY: BRONCHOTOMY THROUGH THE CHEST-WALL FOR FOREIGN BODIES IMPACTED IN THE BRONCHI.

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THE extraction of foreign bodies that have become impacted low down in the air-passages has always been a subject of great surgical interest, since such impactions are necessarily of serious import. This paper is only intended to deal with those cases where the body has become lodged in the bronchi, as those arrested in the larynx or trachea are much more easily reached by surgical measures.

In order to determine the possibility of successfully reaching the bronchus through the chest-wall, the following experiments were instituted upon dogs, since so serious an operation demands thorough experimental work before it is attempted upon the human subject; and as this question may be brought to any of us at a moment's warning, it cannot be too speedily settled.

I approached the subject free from bias as to its possibility, desiring only to prove or disprove its feasibility. The experiments are, of course, too few in number to settle the question, but they are placed on record as additional testimony, and to show the extreme inherent difficulties and dangers which must be met in our attempts to invade the thorax.

We have so successfully advanced both in cranial and abdominal surgery that we are warranted in reviewing anew all the conclusions of the past in an honest effort to secure substantial and life-giving progress in the surgery of the future.<sup>1</sup>

<sup>1</sup> Interest in this subject has recently been reawakened by a case in a neighboring city, where a cork half an inch in diameter became lodged at the bottom of the left



My experiments thus far tend to prove:

1. That the collapse of the lung on opening the thorax, when a lung has not been crippled by disease, is an exceedingly serious and dangerous element, adding greatly to the previous shock, and threatening at once to overpower the patient.

2. The difficulties of reaching the bronchus, especially upon the left side, are exceedingly great and the risks of hemorrhage enormous.

3. Incision into the bronchus necessarily leads, after closure of the chest wound, to increasing pneumothorax, with its subsequent dangers.

4. The delays in the operation from the collapse of the patient must necessarily be great. Rapid work is impossible when the root of the lung is being dragged backward and forward at least half an inch in the efforts occasioned by air-hunger, and precision is almost impossible.

5. To reach the bronchus is sometimes feasible, but to successfully extract a foreign body from it and secure recovery is as yet highly problematical and will require many advances in technique. The anatomical surroundings are those most essential to life.

EXPERIMENT I.<sup>1</sup> *Death from ether; subsequent tracheotomy and bronchotomy.*—Large white and liver colored blind setter, weighing seventy-five pounds. On account of his size this dog was selected, with a view of performing tracheotomy and of introducing a foreign body into the right bronchus, which, by reason of the large diameter of the trachea, could readily be done.

primary bronchus. The case is reported by Dr. Rushmore in the New York Medical Journal of July 25, 1891.

Dr. Rushmore, after two unsuccessful attempts to extract the body through the trachea, attempted an operation for reaching the bronchus through the thoracic wall, but he was obliged by the collapse of the patient to suspend his procedures before the chest was actually opened.

<sup>1</sup> These experiments have been made possible by the helpful assistance of Drs. Sailer and Hinkle, and Mr. Nicholson, whose efficient aid and suggestions saved much loss of time. I have also made a number of experiments in pneumonectomy and pneumonotomy in continuation of those made by Dr. Sailer and Messrs. Patek and Bolgiano (Univ. Med. Mag., May, 1891, p. 473), which I shall endeavor soon to publish.



Before the dog was thoroughly etherized, however, he suddenly ceased to breathe, and all efforts to resuscitate him by artificial respiration were unavailing. He was accordingly utilized by opening his trachea and introducing a pebble the size of a chestnut. An opening was then made in the chest-wall about midway between the sternum and the spine in the fourth interspace. The trachea was easily found, and the stone passed down into the bronchus on the left side. Search was made for the stone, but it could not be discovered. The bronchus was opened, the aorta being displaced to reach it, and the pulmonary vein pushed forward. No stone could be found.

The sternum was then removed, as in ordinary post-mortem examinations, but search was still unavailing. The left bronchus lay covered by the pulmonary vein, with the aorta a little behind and to the left. The bronchial arteries and veins were of large size and were wounded at the right bronchus in the search. The vena azygos minor crossed so close to the root of the lung that it would have been wounded during any operation. This bronchus was opened, but it contained no stone. After deliberate search through the substance of the lung, and also in the trachea, the stone was at last found in the larynx, although the dog had been held in a sitting position during its introduction. The same thing happened on another dog while being experimented upon, showing the remarkable power of reverse action in the trachea and bronchi, if such it was.

Favier and Sabatier, in experimenting for the removal of foreign bodies from the air-passages in dogs, also found that the objects were always expelled voluntarily after tracheotomy, even when pushed well down into the bronchus and buried with the forceps. They were rejected whether the dog was lying down or upright.

EXPERIMENT II. *Pebble in bronchus; bronchotomy; death; stone found in larynx.*—White cur dog, male. Etherized, shaved, and antiseptically cleansed. Incision was made far back toward the spine in an endeavor to reach the bronchus from behind at the root of the lung. Division of the skin and pectoral muscles gave but little hemorrhage. The incision was carried back into the erector spinæ group, from which free hemorrhage occurred, requiring the use of hæmostatic forceps, ligatures, etc. The periosteum of the fourth rib was split longitudinally, and the bone enucleated with a blunt knife and curved hook. The fifth rib was treated in the same manner, and an inch and one half removed from each with bone forceps. When



the pleural cavity was reached the lung immediately collapsed. Stripping the ribs from the periosteum permitted later opening of the chest cavity.

Before the pleura was opened tracheotomy was performed, and a stone carried well down into the bronchus with a pair of forceps before it was dropped. Search was then instituted, but from the time the lung collapsed the dog was in an extremely bad condition, and died before the bronchus could be opened, although the stone could be easily felt in the right tube. Artificial respiration was of no avail.

After death the bronchus was opened, and although the stone had been carried well down into place, and had been felt in that position, yet the result was the same as reported in the previous case, the stone being ultimately found in the larynx. By what means it had worked its way there could not be ascertained, as the dog was upon a level table and was not inverted.

The difficulties in securing and maintaining perfect antisepsis in dogs are very great. Their distaste to dressings of all kinds is so persistent that the only method of enforcing continuous cleanly applications seems to be by an enveloping outside bandage of gypsum.

EXPERIMENT III. *Bronchotomy through the thoracic walls; death in two days.*—Large, white, male bull-dog, strong and vigorous. Etherized, shaved, and made antiseptic. A large incision was made on the right side, commencing two inches from the spine, in order to avoid the erector spinæ group and to provoke less hemorrhage. One rib was resected subperiosteally, as in Experiment II. As soon as the pleural cavity was opened the lung collapsed, and the dog became deeply cyanosed. Respiration was shallow, and soon ceased—the heart's action, however, continuing. The wound was closed with a sponge and artificial respiration instituted. After a few minutes the color returned in his tongue, and he was placed upon his back. This process had to be repeated every few minutes during the entire operation. As soon as he was turned upon his left side the weight of the lung and the air-pressure were so great that he immediately ceased to breathe. As the operation could not be proceeded with he was turned with his right side uppermost, the opening was closed, artificial respiration performed, and he resumed breathing. When on his back respiration could be maintained but two minutes, and it was not deemed safe to do tracheotomy or actually to introduce the foreign body. The upper lobe of the lung was, therefore, turned forward,



the bronchus cleared from the surrounding vessels and incised for one half inch. Very free hemorrhage occurred from wound of the pulmonary vein. This was controlled by hæmostatic forceps, and afterward by chromicized catgut ligatures above and below the wound. The opening in the bronchus was then stitched with chromicized catgut, the gut being threaded upon a small, sharply curved needle. Three interrupted sutures were thus inserted and tied. The chest cavity was cleared of blood. The incision in the chest was then thoroughly sponged and rendered as clean as possible. The deep muscles were drawn together by sutures and superficial stitches added.

The dog rallied well, and on the following day ate and drank. Two days later, however, he died. Cause unknown, as through an error I was not notified until after he had been buried, consequently the post-mortem examination was lost.

EXPERIMENT IV. *Thoracotomy; excision of ribs; bronchotomy; puncture of pulmonary vein.*—Liver and white colored male dog; weight, forty pounds. Etherized, shaved, etc. Incision on the left side in the mid-lateral region between the third and fourth ribs. Four inches of the fourth rib resected periosteally without opening the chest. The pleura was then incised and the upper lobe drawn out. As the dyspnœa in the former case was greatly relieved when the wound in the chest was closed or rendered smaller, an attempt was made to prevent the great inrush of air by drawing out the lobe of the lung and passing it through a slit in a sheet of rubber-dam, thus making an impervious veil and assisting in the relief of air-pressure. The dam was pushed back until the bronchus of this lobe was exposed outside of the slit. The bronchus was bare of pulmonary vessels, and was quickly and easily incised without injury to them. The amount of collapse was less than in the former case, possibly because the left side was being operated upon, and the weight of the heart did not press so heavily upon the left lung, as the heart was in the reverse position. The dog suffered but little from air-hunger. One stitch was easily placed with a curved staphylorrhaphy needle, and matters looked favorable for a speedy and safe completion of the operation, as the dog was doing well. In placing the second stitch, however, a sudden movement of the root of the lung caused the point of the needle to enter the pulmonary vein, and a gush of blood ensued. This was conducted from the chest by the rubber-dam trough,



and the punctured vessel was seized with a hæmostatic forceps and thoroughly tied by passing a catgut ligature beneath the vein with a blunt-pointed aneurism needle. The vein was tied above and below the wound. The placing of the second suture was followed with like result, the lung being dragged out of the hands of the operator during the strong inspiratory movement. More hemorrhage ensued, but was controlled in the same way. Other ligatures were placed, but the blood ran into the opening of the bronchus, and the dog was finally killed, since there was no prospect of his more than rallying from the operation. After death it was found that one stitch had been nicely placed in the bronchus, and that the pulmonary vein had been torn by the point of the second needle, but had been secured by ligature. The bronchus was not thoroughly cleared from the surrounding structures before incision was made, hence the accident.

EXPERIMENT V. *Thoracotomy; death from ether and collapse of lung.*—Incision on the left side opposite the seventh rib, which was resected periosteally. Anterior part of the bronchus of the left upper lobe exposed and cleared, when the dog suddenly collapsed from heart-failure, or perhaps from pressure upon the pericardium, with probable rupture of the septum between the lungs. Artificial respiration proved of no avail.

In this case the posterior part of the bronchus of the middle lobe was easily reached and seen. The aorta lay to the left, with the pneumogastric a little posteriorly, so that it would have been easy to have reached the bronchus. The upper bronchus anteriorly was also easily exposed. Incision at the seventh rib is a little too low. The bronchus had been thoroughly isolated when the collapse occurred, and could have been easily incised. Rubber-dam was used as a valve.

EXPERIMENT VI. *Thoracotomy; bronchotomy; suturing of wound; death fifteen minutes after completion of operation.*—Large black and white mongrel; weight, thirty pounds. Incision on right side. Fifth rib excised subperiosteally, but a serious hemorrhage occurred from the intercostal artery, which was finally controlled by ligature. The bronchus of the first lobe proved to be inaccessible, both anteriorly and posteriorly, being deeply concealed and covered with the pulmonary vessels. The bronchus of the second lobe was reached anteriorly and incised for one-third of an inch.

Three chromicized catgut sutures were introduced into the side of



the bronchus wound and tied, a staphylorrhaphy needle being employed. The difficulties and delays in the operation were found to be the same as in the previous cases from the fact that resuscitation had to be performed many times after apparent death. The dog, however, was kept alive and the wound closed. He did not rally, and died in fifteen minutes.

The post-mortem revealed no hemorrhage; bronchus cleanly cut, without injury to surrounding structures, and sutures well placed.

EXPERIMENT VII. *Excision of ribs; bronchotomy; large pulmonary veins; death.*—Skye terrier, male. Etherized. Incision laterally from the point of the scapula. Fourth rib resected. A three-inch incision on the left side. Immediate collapse of lung on admission of air. Shock so great on collapse of lung that but little ether was subsequently required. The bronchus of the upper lobe found concealed by enormous pulmonary arteries and two huge pulmonary veins which lay in front, completely covering it. These were carefully isolated, but the great depth of the bronchus rendered it entirely impossible to incise it, as the vessels could not be held out of the way. The bronchus of the middle lobe was exposed posteriorly. The aorta and pneumogastric lay absolutely upon it, so that operation seemed hopeless, but it was at last incised without injury to the vessels. One stitch was safely inserted with a staphylorrhaphy needle, but the bronchus being very brittle the second stitch tore out, and the dog, having been resuscitated eight times during the operation, finally died.

The relation of the bronchus to the pulmonary vessels was found entirely different from the previous cases, being much larger and the bronchus deeper. The root of the lung, also, was situated low down in the thorax, so that the incision was too high. The fifth rib would have been better.

EXPERIMENT VIII. *Simple incision of bronchus without stitching; death from increasing pressure of pneumothorax.*—Black and white mongrel, male; weight, twelve pounds. Etherized, shaved, and rendered antiseptic. Incision on the right side. Excision of the fifth rib one inch and a half. The bronchus leading to the right upper lobe was exposed. The bronchial and pulmonary veins were pushed aside. Very large azygos vein. The bronchus was incised for one-third of an inch without wounding any other structure. No hemorrhage took place. The pleural cavity was cleaned of a few drops of blood issuing from the divided intercostals. The intercostal



and pectoral muscles were stitched with continuous suture of catgut, securely closing the chest. The skin was also closed in the same manner. The line of suture of the muscles showed a constant tendency to bulge, and the air soon burst through it at each inspiration. The dog breathed with comparative ease, and was rallying, while the wound was partially closed. So soon, however, as complete closure was accomplished, the dyspnoea became more marked, the tissues being pushed out more and more at each inspiration. The pneumothorax steadily increased, pushing the heart to the left and with it the septum, thus interfering with the left lung. Death speedily ensued.

The opening in the bronchus evidently permitted the air at each inspiration to escape through the incision into the pleural cavity, but from the cylindrical shape of the tube return was prevented by closure of the slit. The action was that of a force-pump driving more air into the pleural cavity, which is probably the explanation of the increasing pneumothorax.

An examination of the parts after death showed that the incision had been cleanly made in the bronchus, and that no injury had been done to any vessel or nerve-structure in the line of the wound. There was no hemorrhage, and death was apparently from the cause mentioned.

This experiment was made to observe the effect of a wound left open in the bronchus without stitching. The increasing pneumothorax seemed to be caused by the valve action of the bronchial slit.

It has been demonstrated that the air of the bronchi is septic, and that it only becomes aseptic by the time that it reaches the bronchioles and air-vessels.

My experiments show that upon the left side the bronchus of dogs is enveloped by the pulmonary veins and arteries and bronchial vessels, and although the aorta and pneumogastric can be speedily recognized, yet the cardiac and pleural branches of the pneumogastric run so closely to the root of the lung that the dangers upon the living animal are simply enormous, and in a human patient I cannot imagine a more appalling array of difficulties than would meet the surgeon in such an attempt, with these enormous vessels on either side and the heart in close



proximity. Combined with the labored movement of the lung, the operation is one beset with extreme difficulties.

On the right side, while the array of obstacles is not quite so serious, yet the danger is increased by the close proximity of the azygos vein, and in dogs the pressure of air upon the septum, together with gravity, pushes the heart so far to the left, and interferes so greatly with the action of the only lung which is capable of rendering service at this time, that it occasions greatly increased risks from apnœa.

Dr. Rushmore states that in the cadaver, however, the operation is not difficult, but expresses doubt as to the condition of a living subject. I can say that in a dog the aspects of the parts during life and after death are as absolutely different as they can possibly be. A bronchus which after death is easily exposed, and which is reached with the greatest ease, I have seen five minutes previously absolutely enclosed with huge pulsating vessels of twice the size, any one of which if punctured would seriously complicate if not render the operation absolutely fatal. The alteration of the parts in life and in death can only be appreciated when seen.

I attempted a posterior entrance in a number of experiments, but found a much more serious delay from hemorrhage of the great veins which supply the erector spinæ group of muscles.

The plan of Nesiloff consists in opening the thoracic cavity in the posterior mediastinum from behind by the resection of the ribs without touching the pleuræ. As the relation of the parts is different in dogs, this cannot be so readily accomplished in experiments.

The patient should be laid upon his abdomen and a vertical incision made parallel to the vertebræ, three inches to the left; two horizontal incisions are carried toward the vertebræ from either extremity of the first, and the flap raised. A sub-periosteal incision of the third, fourth, fifth, and sixth ribs is then performed either by removing them or by bending them by fracture, so as to replace them after the operation. The pleura is then pushed forward and the bronchus searched for. This opera-



tion has been employed to reach the œsophagus, and it is possible that it may yet be used in searching for the bronchus.<sup>1</sup>

Quène and Hartmann<sup>2</sup> have advised the opening of the posterior mediastinum by a vertical incision over the angle of the ribs, between the spinal border of the scapula and the vertebral column, about four fingers' breadth from the spine, the middle of the incision corresponding with the spine of the scapula. They state that the upper lobe of the lung and the summit of the cavity is thus made easily accessible, and that this is a better route than the resection of the ribs below the clavicle.

The operation has not been done, so far as I know, in man; and while it would be of advantage for reaching the œsophagus, the same difficulties that have already been mentioned would be inevitable in any operation upon the bronchus. It may serve, however, as a route for an entrance into a tubercular cavity of the upper lobe—local surgical treatment of which will, in my belief, at some future day be practicable. It may also prove useful in reaching the vertebral bodies for caries.

In this operation the trapezius is pushed aside instead of being incised. The ribs are excised from the second to the sixth sufficiently to permit the penetration into the posterior mediastinum. The hilum of the lung might possibly be reached by this route, by stripping off the pleura instead of incising it, thus avoiding the great danger arising from the entrance of air into the pleural cavity.

The operation which was attempted by Dr. Rushmore, but which was not completed, was the making of a flap three inches long and three inches wide, with its detached edge along the left clavicle. He had cut through and pushed back the pectoral muscles, and was about making the section of the ribs with a saw, when he was compelled to desist his efforts in order to revive the patient.

<sup>1</sup> In the *Journal of the American Medical Association*, June 25, 1891, it is stated that Figuera was experimenting upon this subject by the posterior incision, but I have seen nothing published by him.

<sup>2</sup> *Bulletin et Memoires de la Société de Chirurgie de Paris*, vol. xvii, 1891, Nos. 1, 2. *University Med. Magazine*, July, 1891, p. 644.



The difficulty in extraction through the trachea in this case was that the round body, half an inch in diameter, accurately fitted the cylindrical bronchus, and gave no opportunity for the forceps to grasp it unless the bronchus could be first dilated sufficiently to allow the jaws to pass between the walls of the tube and the cork. He employed various devices for securing the object after tracheotomy with division of the second, third, and fourth rings. Air-pump suction worked perfectly well in experimenting upon rubber tubing and cork, yet it could not dislodge the object when held by the swollen mucous membrane of the bronchus. Instruments with concealed hooks he discarded as useless on account of the impossibility of accurately distinguishing between the cork and the mucous membrane. This I have found an exceedingly difficult thing even with rougher bodies than cork, as the cartilaginous rings give a firm sensation to the probe, greatly resembling a foreign body. Piano-wire loops were also tested by experiment on tubing, but the loop would not pass beyond the body. Adhesive substances were found to be useless on a moist surface. With Tiemann's œsophageal forceps he was able to distend the rubber tubing and grasp the cork. These seemed the most hopeful methods of relief offered, and they were used at the first operation. At the second operation he thought his instrument touched the cork. This, however, was only conjecture.

At the first operation the patient was etherized forty minutes, when, as the object was not found, he was allowed to recover. His temperature varied subsequently from 100° to 103°.

The second operation was attempted five days later. The patient labored under increasing difficulty of respiration. There was dulness over the left thorax, and he was evidently sinking. A corkscrew, concealed in a hollow tube, 30 French calibre, twelve inches long, slit from end to end for the purpose of respiration, was employed. This apparatus consisted of three portions, an outer envelope, an inner tube, with two concealed spikes, and within this a long-handled corkscrew, which could be easily rotated. He was able to reach the cork and was satisfied that the spikes were not fixed in the wall of the



bronchus by rotating the whole instrument on its long axis. The screw having been presumably driven into the cork, traction was made. The coil, as was proven later, pulled from the cork. The patient coughed up a moderate amount of bloody mucus, and, breathing with markedly increased difficulty, became deeply cyanosed, which cyanosis continued until the end of the operation.

The difficulty of respiration was increased, and it was believed that the cork had passed over to the right bronchus. After ten or fifteen minutes' further search the anterior operation, as described, was attempted, but abandoned. Death occurred five days later, the condition never again warranting operative procedures.

At the post-mortem examination the cork was found at the bifurcation of the left bronchus. The lower end of the cork was broken off, probably before it was swallowed. The mucous lining was sloughing and congested. Pus oozed from the small bronchi. The lung was hepatized. The right lung was slightly congested and œdematous. Two punctures were found upon the upper surface of the cork, and a small piece was missing.

When a foreign body becomes impacted in the bronchus, the gravity of the injury becomes more and more serious. According to the statistics of Weist and others, a large percentage of these are fatal ultimately, either from pneumonia, gangrene, abscess, or other complications.

On a careful physical examination to determine the site of the impaction, the quality of the sounds elicited on percussion will vary from slight dulness to flatness according to the amount of blockade, and also with the nature of the body itself. The primary percussion note will not be altered except where there is complete obstruction. Later, if pleurisy or pneumonia supervene, of course the ordinary physical signs will be present. If there is entire obstruction, or if complete collapse occurs, there will be but little, if any, movement of the ribs.<sup>1</sup>

<sup>1</sup> Stengel (Univ. Med. Mag., August, 1891, p. 729; Brit. Med. Journ., April 25, 1891) says that we can determine definitely by auscultation which bronchus is filled. If the air does not pass in, then it is entirely occluded; if the sounds are sibilant on inspiration, the obstruction is incomplete and the opposite side will be normal. The sound will, of course, vary as the object is tubular or solid. In partial obstruction of the bronchus a portion of the lung may be resonant.



A metallic substance will, of course, give forth a more whistling sound, and peculiar-shaped bodies may occasion strange notes. The respiratory murmur may be altered in tone—may be extinguished or altogether lost, while upon the opposite side respiration will usually be puerile.

The primary symptoms of bronchial impaction are usually dyspnoea, livid face, spasmodic cough, pain in the chest, and less interference with the voice than in laryngeal impaction. Thoracic pain is usually present and very constant. Expiration is ordinarily more difficult than inspiration.

The prognosis of these cases is much more serious than in tracheal and laryngeal obstruction, and the chances of securing the body either by operation or by voluntary expulsion are greatly diminished.

It must be remembered that foreign bodies sometimes shift from one bronchus to the other. The right bronchus, being almost in line with the trachea and occupying as it does nearly three-fifths of the area of the tube (from the fact that the point of division lies to the left of the median line), is most likely to receive the foreign body. Cheadle found that in thirty cases, sixteen were on the left side. Kocher gives Sanders' tables of twenty-one deaths without operative interference or expulsion, of which ten were in the right bronchus, none in the left. In thirty-four cases operated upon, thirteen were on the right, five on the left.

Beleg gives thirty cases, in which nineteen were in the left bronchus.

The right bronchus is three-quarters the size of the trachea; the left, one-half. The right is about one inch in length; the left, two inches.

**VOLUNTARY EXPULSION.**—This is so common an occurrence that this end should not be despaired of even when the body is within the bronchus. Of course, this will depend somewhat upon the character of the foreign body. Seeds of all kinds will naturally swell under the action of heat and moisture, and may at first occasion increasing obstruction, but as softening occurs, expulsion may be accomplished by a voluntary effort of the



patient. Hence the policy of non-interference in seed impaction is usually the wise course. Expulsion usually occurs in the first few hours, but it may be delayed for weeks; one case is on record where a bone remained for sixty years. Secondary expulsion may occur after ulceration and abscess, and, although these cases even end in recovery, yet such degeneration of the lung frequently results in death. A body occasionally becomes encysted; night-sweats and emaciation often follow, and the tubercular process may be engrafted upon the inflammatory lesion.

INVERSION.—Many authors advise against inversion of the body, but in my judgment this procedure is advisable in bronchial impaction, especially when the substance is metallic, and particularly after tracheotomy, when the risk of its lodgment in the larynx has been greatly diminished. Campbell reports a death from hemorrhage during inversion, but this is exceptional.

Statistics of foreign bodies impacted in the bronchi show a slightly increased percentage in favor of non-interference. When, however, the obstruction can be located, a low tracheotomy is justifiable with cautious attempts at extraction. These should not be prolonged, nor should imprudent force be used.

Considerable difference of opinion exists upon the propriety of operation in bronchial impaction. Kocher says that operation for the removal of foreign bodies is but an experiment. Weist proves almost conclusively that nearly 90 per cent. will recover without operation. Westmoreland favors operation when the foreign body is in the upper air-passage, but when in the bronchi it is not advisable. When a foreign body becomes impacted in the bronchus, extraction is an impossibility in 78 per cent. of cases even after tracheotomy.

Weist considers that the mortality is increased by tracheotomy in bronchial impaction, since the risks of the operation are added to the primary danger together with the perils arising from the temptation in the hands of a rash surgeon to prolong operative efforts. Ulceration and perforation may result. Small, hard bodies are the ones most liable to drop into the bronchus, but they seldom pass beyond the binary bifurcation.



Gross advises that not more than three attempts of one minute each should be employed with forceps to remove a foreign body.

The danger of the operation is largely increased by injurious instrumentation. Thirty per cent. of the deaths following operation are from pneumonia, while this disease causes death only in 18 per cent. of non-operative cases. Still, as Rushmore wisely remarks, when the deaths from broncho-pneumonia are added the results are practically similar. The failure to extract a foreign body even after operation in 78 per cent. of cases is certainly an unfavorable showing, but from my experiments upon dogs, I certainly am not inclined to believe that the chances of recovery would be increased by approaching the bronchus through the chest-wall.

For the purpose of extraction, forceps of various curves are required. Gross's, Cohen's, Mackenzie's, or Cusco's lever-bladed ones are the best. D'Etiolle's spoon, or a bent wire, or a blunt hook, may sometimes be required, varying with the nature of the body to be extracted.

The forceps, though slender, should be exceedingly strong, and should have simple serrated edges, so as not to wound the mucous lining of the tube. After the body has been fixed by inflammatory action, however, extraction is often impossible with these forceps. In the case of round bodies, as peas, beans, and peculiar-shaped substances, forceps with sharp teeth are permissible in order to prevent slipping. The manipulations must be performed with extreme caution, and the withdrawal must be slow. Instruments acting upon the plan of a corkscrew are occasionally employed, but a soft substance capable of being penetrated by such a device would render the diagnosis of its having been grasped an obscure one.

Suction by a Bigelow litholapaxy pump through a tube with an open end would be useful for the removal of small articles. Such a tube could be made much larger than the ordinary urethral one, or rubber tubing can be employed. I am experimenting with a rubber tube that can be expanded so as to occupy the entire calibre of the bronchus, and thus give strong suction-power.



After tracheotomy the wound should be kept open by blunt hooks or by stitches, never by a canula, which would block the exit and prevent the voluntary expulsion which is so common even after failure with instruments. The dressing should be simply loose gauze, to exclude the dust without interfering with the exit. The air should be heated after the operation to 80° or 85°, as I am satisfied from experience that all tracheotomies do better in a high temperature.

When the opening in the trachea gives entire relief from dyspnœa, it is very improbable that any object is fastened in the bronchus. Tracheal mirrors with electrical illumination, as well as laryngeal ones, should be employed in the diagnosis after tracheotomy. The greater the extent and duration of the dyspnœa the greater will be the danger from pneumonia after tracheotomy.

The work of Avonssohn, Gross, Durham (Holmes' *Surgery*), Weist, and others have made possible many successful results.<sup>1</sup> It is certainly impossible for any surgeon to diagnosticate beforehand whether his individual case is one of those in which the obstruction will be loosened and coughed up, or whether it will remain, producing gangrene, pneumonia, or subsequent abscess, consequently each case should be most thoroughly considered.

Bronchus originally meant the windpipe, while the two primary divisions were named bronchia, hence the term bronchotomy was used to designate any opening in the air-passages of either larynx, trachea, or bronchus; and Gross and other writers, even as late as Weist, still use the term to designate the high operation. It should be confined to operation upon the bronchus, as laryngotomy and tracheotomy properly designate these higher operations.

Weist (TRANS. AMER. SURG. ASSOC., Vol. I.) gives an accurate and careful analysis of 1000 cases of foreign bodies in the larynx, trachea, and bronchus, as will be remembered by all the members of this Association. In it he shows conclusively that the simple presence of a foreign body is not an absolute indication for operation, as had been previously held by most surgical

<sup>1</sup> Bourdillat gives a large collection of cases (Poulson, "On Foreign Bodies," p. 33) Also, Maurice Perrin gives statistics.



teachers. While operation is the rule, yet there are modifying circumstances. His conclusions were that 76 per cent. of non-operative cases recovered, and 72 per cent. of those operated upon, but, of course, the latter were the worst class, as the former included many in which early expulsion took place. Weist does not advise opening simply because a foreign body is present; there must be some other indications. He advises non-interference when a foreign body remains quiet and the symptoms are not serious, but favors operation when the body is movable and when there are frequent attacks of suffocation.

Smith gives 1600 cases, with 70 per cent. of recoveries of non-operative cases and 76 per cent. of operative ones, the proportion being one death to every three and a half cases not operated upon, and one death to every four of those operated upon.

Durham gives 50 per cent. of recoveries in non-operative cases and 77 per cent. of operative ones; also, he gives 74 per cent. of tracheotomy recoveries. Guyon and Durham, in 1674 cases, give 70 per cent. of recoveries in non-operative cases and 75 per cent. in operative ones.

Medico-legal cases arise in connection with impacted objects in the bronchi, as death is sometimes sudden. Only a few days since a mother was arrested for killing her child. Post-mortem revealed the fact that during the operation of spanking, the child had swallowed a button, which had caused almost immediate death by lodgment in the bronchus.

CONCLUSIONS.—1. The bronchus in dogs can be reached either anteriorly or posteriorly through the chest-walls, but its anatomical position is in such close proximity to large and important structures that safe incision is a matter of extreme difficulty and danger.

2. Bronchotomy through the walls of the thorax is an operation attended with great shock from collapse of the lungs, and until technique is further advanced is liable to result in immediate death.

3. Collapse of the lung is more serious in a healthy organ than in one previously crippled by disease.



4. The serious inherent difficulties are shock, suffocation from lung collapse, enormous risks of hemorrhage from pulmonary vessels, injury of or interference with the pneumogastric, great and fatal delays owing to the exaggerated movement of the root of the lung caused by the excessive dyspnoea.

5. Closure of the bronchial slit is slow and dangerous. To leave it open causes increasing pneumothorax by its valve action, and also permits the entrance of septic air into the pleural cavity.

6. Although a foreign body can be reached by this route, yet removal is hazardous. To secure a subsequent complete cure seems in the present state of knowledge very problematical.

7. When the presence of a foreign body in the bronchus is definitely determined, and primary voluntary expulsion has not been accomplished, there is great danger in permitting it to remain, even though it may but partially obstruct the tube. The risks both of immediate and of subsequent inflammation are serious.

8. Low tracheotomy is, then, advisable when the presence of a foreign body is certain; it adds but little to the risk, and affords easier escape for the object even when extraction is not feasible.

9. *Subsequent dangers arise from severe and prolonged instrumentation, not from tracheotomy.*

10. Voluntary expulsion is more probable after than before tracheotomy.

11. Tracheotomy is permissible even after an object has been long in position, unless serious lung changes have resulted.

12. The question of tracheotomy will depend largely upon the form, size, and character of the foreign body.

13. The term bronchotomy should be limited to an opening of the bronchus, and should not be employed to designate higher operations.

14. The risks from thoracotomy and bronchotomy following unsuccessful tracheotomy are much greater than the dangers incurred by permitting the foreign body to remain.