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NEW MECHANICAL PROBLEMS IN THE BRONCHOSCOPIC EXTRACTION OF FOREIGN BODIES FROM THE LUNGS AND ŒSOPHAGUS

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IN the early days of bronchoscopy and œsophagoscopy no thought was given to the matter or the mechanical problems of the disentanglement, disimpaction or version of foreign bodies. The whole art of endoscopy was thought to consist of introduction of the instruments. This was considered a formidable task. One text-book stated in effect that if the bronchoscope could not be introduced through the mouth in fifteen minutes a tracheotomy should be done for the introduction of the bronchoscope through the neck. To-day, anyone who has been taught a proper technic, and who has instruments proper for the particular patient, should insert the bronchoscope in less than a minute. In the early days referred to, when the foreign body was seen, forceps were introduced, the foreign body was seized often along with tissues, and the foreign body was ruthlessly torn out at all hazards. In 1914 the author [1] called attention to the necessity of a careful study of the mechanical problems of foreign body disentanglement and removal and illustrated the general mechanical principles he had applied to the extraction of a large variety of foreign bodies. These were added to in subsequent publications [2] and.[3] Since then there have come to the Bronchoscopic Clinic so many different varieties of foreign bodies that now, with a total experience of 891 foreign bodies in the air and food passages, I am able to present additional data that will, I venture to think, place the matter on a scientific basis. By this I mean only a basis; future developments doubtless will make present attainments appear embryonic. It will, however, always hereafter be regarded as fundamental that: (1) A foreign body usually presents a mechanical problem of disengagement, disentanglement, version, method and location of seizure, etc., which must be worked out if low mortality and close to 100 per cent. of successes is to be attained; and (2) conversely, grasping the first part of the foreign body seen and ruthlessly tearing it out is brutal and conscienceless, and will inevitably give a low percentage of successes and a high mortality ratio.

Movements of the Bronchi.—In dealing with the problems of foreign-body extraction due consideration must be given to the bronchial movements, not only because of their increasing the difficulties in certain instances, but even more because of the invaluable aid they render to the bronchoscopist who waits and watches for the advantageous phases of their movements, as herein mentioned in connection with forceps spaces. The shortening during cough is also of advantage in protruding slender bodies that are completely within small branch bronchi, too small to enter, as first pointed out by the author.[2]

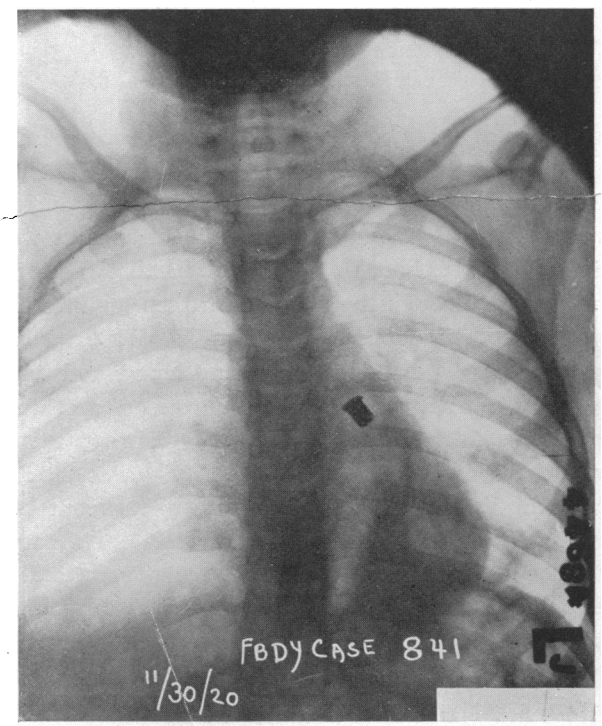


FIG. 1.—Cartridge primer in left bronchus of a boy aged 7 years. The mucosa had swollen proximally until it presented the problem the solution of which is illustrated in Fig. 2. Plate made by Dr. Willis F. Manges.

The movements of the tracheobronchial tree, as I have observed them bronchoscopically, may be categorically enumerated as follows:

1. Expansion during inspiration.
2. Collapsing during expiration, almost all of the collapsing excursion being at the beginning of the expiratory phase.
3. Elongation during inspiration.
4. Shortening during expiration.

5. Excessive contraction in one, many or all diameters during cough. Sometimes in children this bechic contraction is sufficient to obliterate the bronchial lumen. In the trachea of children the posterior (membranous) wall is at times projected forward convexly into the tracheal lumen.

6. Excessive shortening during cough.

7. Displacive movements in various directions, but chiefly sidewise, caused by the movements of adjacent viscera, chiefly the heart and great vessels, but in some instances by the opposite lung.

It must be remembered, that, though here listed separately for clearness, two or more of the bronchial movements are often combined, as elsewhere mentioned.[2]

Education of the Eye and the Fingers.—Nothing will take the place of work with the eye at the tube. The gauging of depth comes only slowly by dint

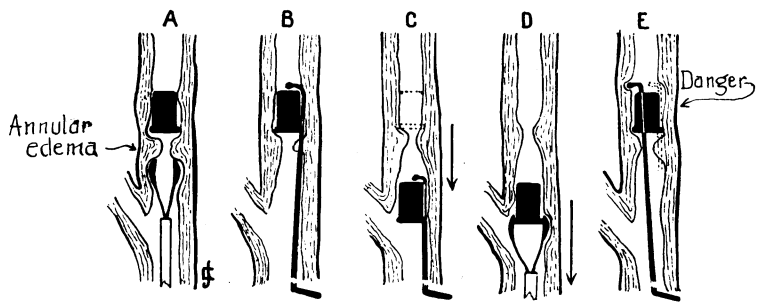


FIG. 2.—How a special probe-ended hook was used to withdraw the primer cap shown in Fig. 1 to a higher, hence wider, location in the bronchus, so forceps could be applied. Removal required 18 minutes and 33 seconds (Case No. Fdby. 841). At A is shown the impossibility of applying forceps because of the proximal annular edema. At B the hook has been insinuated past the cap. C, the cap withdrawn above the edematous area to a widening of the bronchus where a lateral branch is given off. In this location it was easy to apply the forceps securely for the withdrawal (D). In using hooks it is necessary to be exceedingly careful to avoid pulling when the hook slips around to the wrong side (E). Pulling then might cause fatal trauma. No hook of more than a half turn (90 degrees) should be used because of the risk of getting caught in a branch-bronchial orifice. Usually they are better made spirally.

of long practice. Manipulations to be safe must be guided by the eye, and it must be a trained eye. Coördinate manipulations of the tube and forceps must be practiced until work is as natural and familiar as with knife and fork. It is as impossible as it would be brutal to attempt to acquire this coördinate skill by practice on the living human being. Appalling mortality and failure to acquire the skill would result. Fortunately the simple rubber-tube manikin [3] serves the purpose perfectly, as it is always available for practice in spare moments. Next should come practice on the cadaver and on the living dog with foreign bodies of various kinds placed in the bronchi. One is never through practicing for the general education of the eye and fingers. In addition to general practice with miscellaneous objects, when a foreign body case comes in, the endoscopist should place a duplicate of the foreign body in a rubber tube of the size of the invaded bronchus, and by manipulation with bronchoscope, or œsophagoscope, as the case may be, he can familiarize himself with the appearances of the foreign body in every

possible presentation and he can study and work out a solution for every possible problem. A little ingenuity will closely simulate every difficulty to be encountered in the living patient. For instance, little useful practice will be afforded by removing peanut kernels loosely rattling round in a rubber tube of large diameter. Peanut kernels are not encountered that way in the living human bronchus; they are tightly bedded in the smallest bronchi they can enter. For simulating actual working conditions a half kernel should be pushed down into a rubber tube in which it is a tight fit. Then let the practitioner practice the removal as mentioned under "Peanut Kernels." If anyone will follow this plan he will come close to 100 per cent. successful

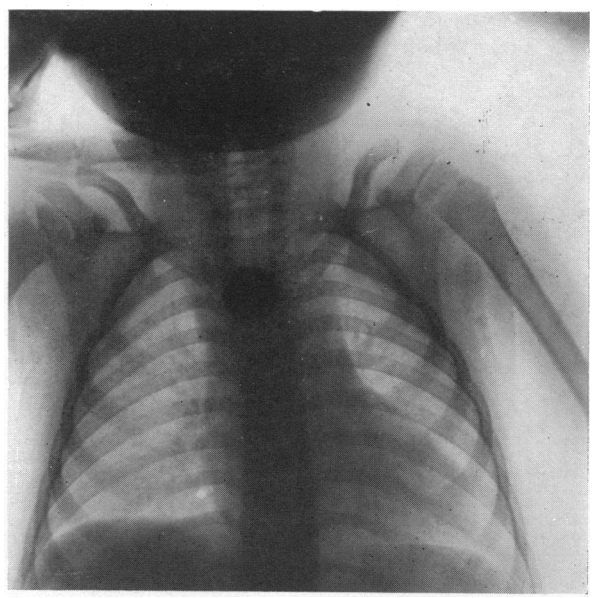


FIG. 3.—This coin is apparently just ready to be easily picked out with any kind of forceps. As a matter of fact a very good endoscopist, after an hour's work under ether, failed to grasp the coin for the lack of appreciation of the very simple mechanical principle illustrated in Figs. 4 and 5. Similar cases are constantly coming to the Bronchoscopic Clinic. Plate by Dr. Willis F. Manges.

removals and will have little or no mortality. I am sure that the appalling mortality that has attended bronchoscopy and œsophagoscopy in inexperienced hands would never have occurred had the operators realized how little chance there is of the survival of a little child undergoing an œsophagoscopy in inexperienced hands. This is true of simply the introduction of the œsophagoscope. How much more forcibly it should apply to complicated removals. For instance, no one should think of attempting the endoscopic removal of a safety-pin without hundreds of hours of training of the eyes and fingers to the unusual requirements of the work. To ignore this is to trifle with human life. It is infinitely worse than to attempt removal of cataracts from a living human eye without previous practice on dead animals'

eyes, which would result in blindness, not death. The removal of an open safety-pin is infinitely more difficult to learn because the cataract operation is a bimanual and binocular procedure to which all surgical work is more or less a fundamental training; whereas foreign-body endoscopy is a monocular, depth-gauging procedure surrounded by so many limitations and difficulties as to place the operator under "an indescribable stress" as Ingals so aptly stated. For a surgeon to telegraph for a bronchoscope or an œsophagoscope the like of which he never saw before and to start down the tender passages of a child in search of an open safety-pin usually ends in involuntary manslaughter, using the term literally, not in its technical sense. The author assumes part of the responsibiiity for these not infrequent deaths. From a mistaken sense of modesty he refrained from stating the case strongly so long as few or none had equal opportunities for experience;

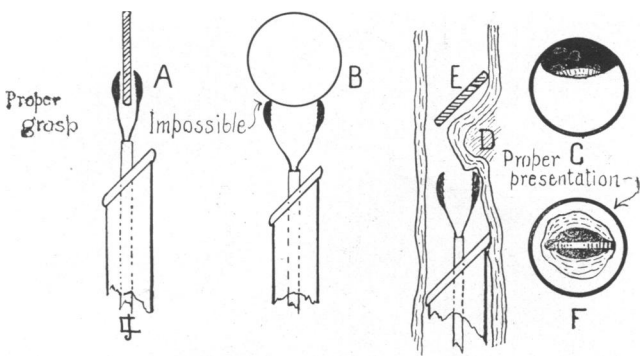


FIG. 4.—The cause of many failures to seize a coin in the œsophagus. The seizure should be flatwise as at A, not edgewise as at B. No attempt should be made to seize the coin in the position in which it is usually first seen, C, because one jaw of the forceps will strike the cricopharyngeal fold, as shown in cross-section at D, preventing the jaws from advancing far enough toward the coin to grasp it properly. The lip of the œsophagoscopic tube-mouth should be used to obtain a proper presentation as shown at F. The same principles govern the grasping of all flat objects in the œsophagus or tracheobronchial tree.

but now that every large medical centre has an experienced endoscopist, there is no more need of totally unexperienced men attempting œsophagoscopy than for every internist to do his own appendectomies.

The study of the presentation is fundamental for safety and success. In foreign-body bronchoscopy, as in accouchement, the ruthless pulling upon any part presenting without consideration of the other parts is to court disaster. Just as the obstetrician studies out the position of the fœtus and every part of its anatomy in relation to the maternal pelvis just so must the endoscopist study the position of the foreign body and the relation of its every part to the invaded bronchus or œsophagus. Just as the obstetrician depends upon abdominal palpation to aid him in his interpretation of the presentation, so the endoscopist studies the röntgenogram made in two planes, the lateral and the anteroposterior, so that he may know, when he looks at the endoscopically visible part of the foreign body, where the other parts lie. The ray-plates should be on a shadow-box in the operating room; and the

author prefers to have the plates placed upside down for a better conception of the relations in the recumbent patient. When the presentation is not a favorable and safe one for delivery, a version must be done, as, for instance, when the pointed limbs of a double-pointed tack [2] are turned away and the head brought into the presenting position—a cephalic version.[4]

Forceps Spaces.—Fundamental in the endoscopic removal of foreign bodies is the matter of forceps spaces, which is the name I have given to the spaces between the foreign body and the wall of the invaded bronchus or œsophagus and into which the jaws of the forceps must go before they can grasp the foreign body. Of all the causes of failure to remove a foreign body whose location has been reached, in the cases coming to the Bronchoscopic Clinic, none is so frequently the evident cause of failure as lack of

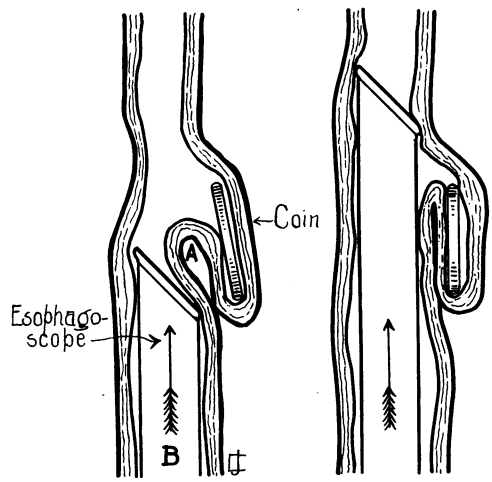


FIG. 5.—How a foreign body is so frequently overriden unseen by the inexperienced œsophagoscopist. The œsophagoscope advancing in the direction of the dart through the normally collapsed œsophagus, pushes ahead of the tube-mouth a fold, A, that obscures the view of the coin, which becomes buried in the folds alongside the advancing œsophagoscope. This is most likely to occur at the cricopharyngeus, but may occur at a number of other locations.

knowledge or appreciation of the fundamental importance of forceps spaces. Over and over again the mucosa in the neighborhood of a foreign body has evidently been traumatized in an effort to force the jaws over the foreign body when no spaces for the entrance of the jaws existed, or futilely jamming the forceps into the mucosa in an effort to force the forceps onto a foreign body with the jaws opening sagittally ignoring the lateral forceps spaces that would have facilitated grasping had the forceps been turned so the jaws would open in the coronal plane. Had the bronchoscopist been working with both eyes and both hands in an open wound, he would make no such mistake but being unfamiliar with the work and never having been taught the necessity of study of the forceps spaces, when he at last finds a foreign body for which he has been searching he thinks of nothing in his haste to use the

forceps. Many blind graspings and jabbings in the neighborhood of the foreign body not only fail to grasp it, but by the blood drawn from the mucosal vessels the intruder is so obscured that recognition afterward becomes impossible, and the foreign body is "lost." Had the bronchoscopist recognized his forceps spaces, or created one or two as the case required, the forceps could have been accurately placed under the guidance of the eye and removal accomplished in a few seconds or minutes at the first attempt. Forceps spaces are usually at their maximum on inspiration. They decrease immediately, not gradually, at the beginning of the expiratory phase of the respiratory cycle.

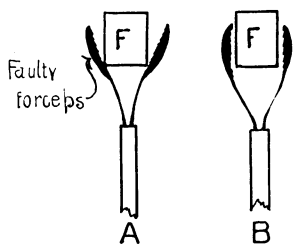


FIG. 6.—Good and bad construction of forceps. The faultily constructed forceps (A) with planes of grasping surfaces divergent, not only afford an insecure grasp, but, by reason of the small area of contact, really only pivotal, permit the foreign body (F) to swing sidewise at every touch of the natural passages, which swinging is sure to result in loosening the foreign body from the grasp of the forceps. Proper forceps (B) have the planes of the grasping surfaces parallel.

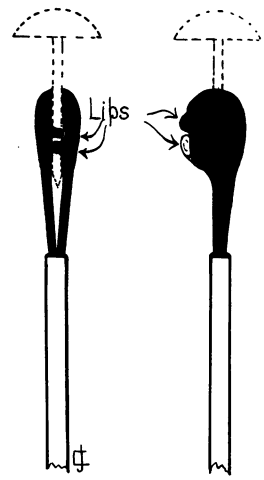


FIG. 7.—Side and top views of the Tucker forceps. The small lips added to one side of the side-curved forceps by Dr. Gabriel Tucker prevent the slipping out of the shaft of a foreign body, such as a tack or a pin, or a safety-pin, during the turning out of the point from the mucosa and the bringing of the point into the tube-mouth. This forceps adds to the Jackson method of safety-pin removal a certainty which makes this method an ideal one. The Tucker forceps are also excellent for the disimpaction and removal of tacks, pins and nails.

In some cases both spaces exist only on inspiration, and the bronchoscopist must wait and watch, with forceps jaws close to the foreign body, for his opportunity, early in the inspiratory phase of the respiratory cycle, promptly, though gently, to insert the forceps jaws into the forceps spaces as they gape. The prompt collapse of the bronchial walls at the beginning of inspiration renders it necessary to start the insertion of the forceps jaws at the beginning of the inspiratory phase. If later, the jaws will be met and stopped by the collapsing walls. Where one space only exists, and that on inspiration, one of the hereinafter mentioned means must be used to get the

foreign body into a new position in which two forceps spaces will appear either continuously or on inspiration. This respiratory opening and closing

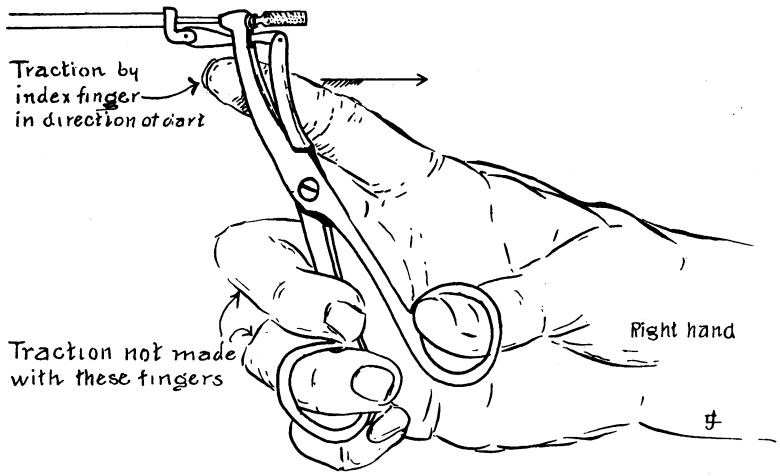


FIG. 8.—Proper manner of holding forceps. The ring-finger in the ring; the index for pulsion and traction.

of the forceps spaces is most frequently seen in cases of peanut kernels in the bronchi, in which class of cases the forceps spaces admit air (See colored

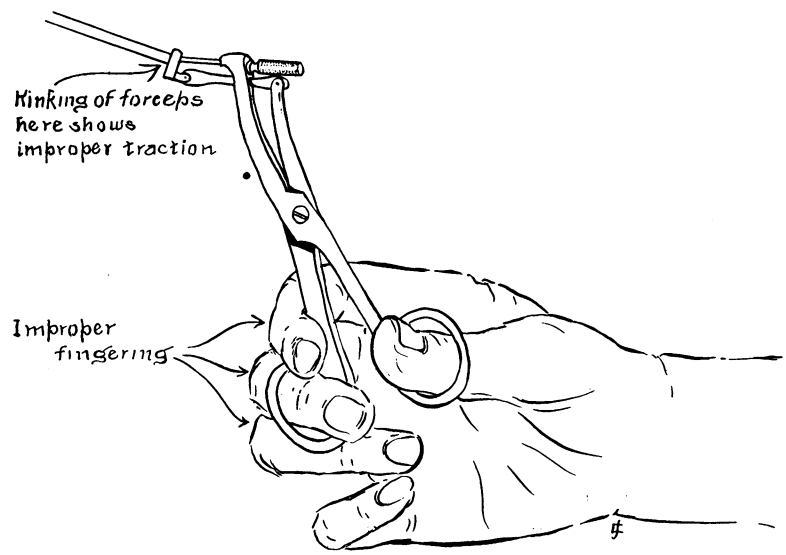


FIG. 9.—Improper use of forceps. Forceps can be so constructed as to do away with the springing upward here shown; but the delicacy of touch essential to safe and efficient work would be thus destroyed.

plate). Where forceps spaces do not exist they may be created by four different means, used singly or in combination of one or more, involving more or less change in the presentation.

1. Displacement of one wall with the lip of the bronchoscope or œsophagoscope.

2. Tilting of the foreign body with the lip of the bronchoscope.

3. Tilting of the foreign body by means of the side-curved forceps insinuated at one side and used as a hook.

4. Withdrawal of the foreign body by means of hooks of certain permissible forms, to a new position in which less swollen walls or a normally larger lumen creates forceps spaces. If withdrawal to the site of a branch bronchial orifice can be accomplished, large forceps spaces are afforded (Fig. 2).

Of all causes of failure of our predecessors to remove a coin in the œsophagus in the cases coming to the Bronchoscopic Clinic, next to failure

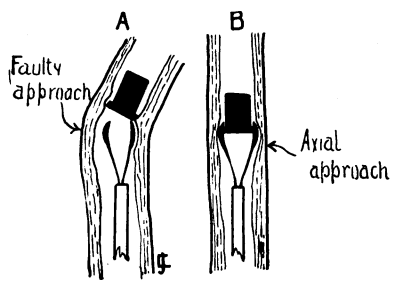


FIG. 10.—If the axis of approach is at an angle (A) instead of vertical to the presenting plane (B) of the foreign body, the intruder will be pushed down without either blade having had any chance to pass outside of the presenting part of the foreign body. The faulty angle of the approach (A) will often be encountered unless the head of the patient is moved in the proper direction to obtain an axial presentation of the bronchial lumen and an axial approach (B) to the foreign body.

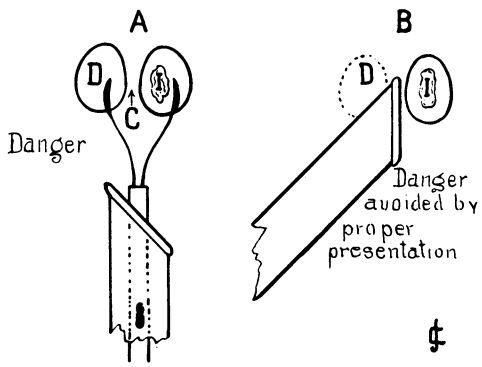


FIG. 11.—How to avoid including the dividing spur in the grasp of the forceps. If in an attempt to grasp the foreign body, 1, the forceps are allowed to expand with the bronchoscope exposing both bronchial orifices as at A, the spur is apt to be caught, giving an insecure hold, and dangerous trauma is almost certain to be inflicted. (See illustration D in the colored plate). By moving the head to the left the foreign body is presented centrally and the spur, C, is out of the way to the left, the bronchial orifice, D, passing out of the endoscopic field of vision and out of harms' way.

to find the coin because of overriding, the most frequent cause has been failure to establish two forceps spaces that would permit of proper approach and proper grasping, as shown in Fig. 10. It seems strange that a man who would naturally pick up a flat object flatwise if he were working at a bench with nippers, will try to put on the forceps edgewise in his haste to grasp a coin for which he has been, perhaps, searching a long time; yet the forceps marks on the mucosa and the statement of the unsuccessful œsophagoscopist showed clearly in dozens of these cases the faults mentioned.

Forceps.—Endoscopic foreign-body work differs from general surgery in that instruments must be properly constructed to obtain a high percentage of successes and a low mortality. The abdominal surgeon may use a kitchen spoon as a makeshift retractor without loss of time or efficiency; but the limitations inseparable from the necessity of working through a long endoscopic tube of small diameter are such that the slightest departure from the required design may make all the difference between success and failure,

indeed between life and death. For instance, the slight departure from the shape of the jaws of the forceps shown in Fig. 6 made the forceps worthless. The endoscopist who failed to hold his foreign body did not realize that though they had been foisted upon him as of my design they were faulty copies of the forceps that have stood my every test for twenty years. When properly made they convey an exquisitely delicate sense of touch. For general purposes the side-curved forceps advocated by me in the early days of bronchoscopy still remain the standby for the majority of the cases, with the plain forceps and the rotation forceps next in usefulness. On rare occasions

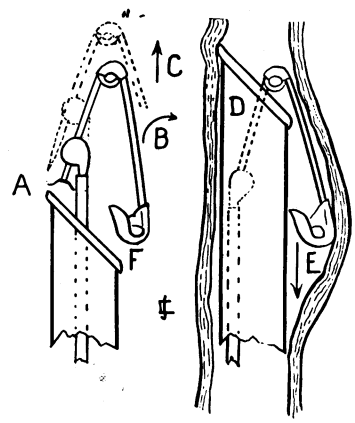


FIG. 12.—Author's method of dealing with the problem of the safety-pin lodged open and point upward. The point of the pin is always sunken into the mucosa as shown at A. The pointed branch of the pin is seized with the forceps, which are then rotated about 90 degrees, so as to get under and turn out the point as the pin is pushed downward with the forceps. This double movement is indicated by the darts B and C. The tube is then pushed downward over the pointed branch of the pin until this branch is completely within the tube (D). The pin is then withdrawn, the keeper sliding harmlessly up outside the tube (E). The keeper really lies closer than shown in the drawing which is made schematically to emphasize the fact that the keeper is outside. Care to maintain the greater plane of the keeper coronally is necessary at the cricoid in the case of the œsophagus, or sagittally at the glottis in case of the tracheobronchial tree.

it has been found advantageous to lock the forceps closed on a foreign body while at work upon it. For this a clamp is applied to the handle.

A number of special forceps for special purposes have been devised. Of my own devices there is no need of mention here. Spencer's forceps hold screws well.

My assistant, Doctor Tucker, has added a lip to the side-curved forceps which overcomes one of the greatest difficulties in turning out the point of pins, safety-pins, needles, tacks and similar objects when the point is buried in the mucosa. The lip is too short to inflict serious trauma from light grasping. Of course, if traction is made upon tissues serious or fatal trauma may be inflicted with any kind of forceps. Care and gentleness are necessary in the use of any kind of bronchoscopic or œsophagoscopic instruments.

As mentioned under "Use of Forceps," heavy construction destroys all delicacy of touch. Great strength is not necessary; but the temper of the steel must be such that it will bend before it will break. Occasionally it may

be desired in the solution of some mechanical problem to clamp the forceps onto a foreign body in a certain chosen position. For this purpose the clamp shown is used. It is so rarely required that it is made detachable and applicable to any of the forceps handles.

The use of forceps requires study and, especially, practice, so that their handling and coördination with the tubal manipulations becomes as natural

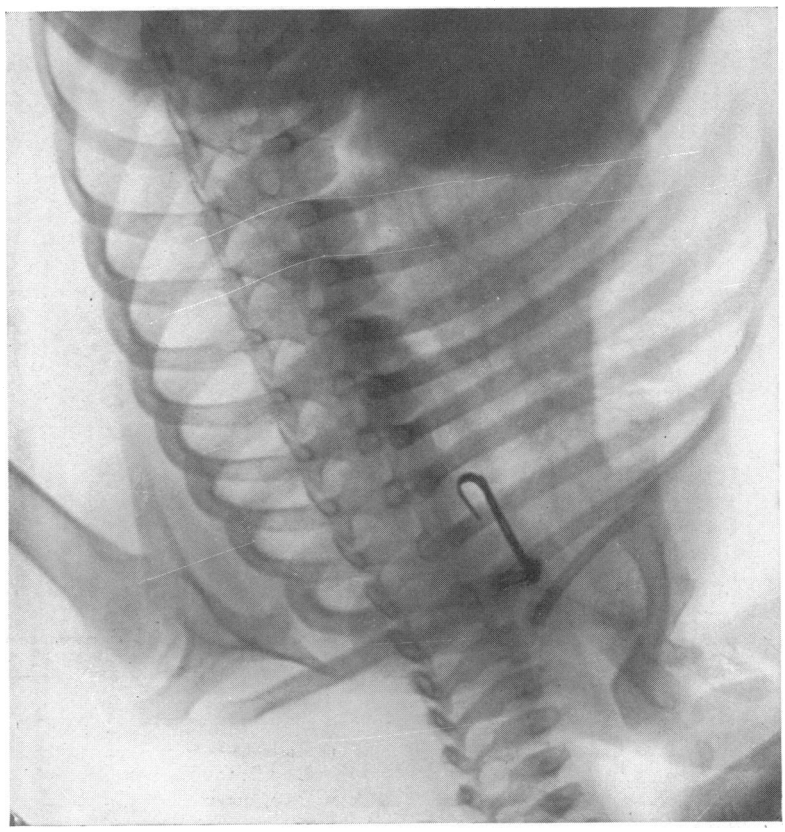


FIG. 13.—This illustration shows the advantage of turning the röntgenogram upside down for œsophagoscopy and bronchoscopy in the recumbent position. This contributes to a proper conception at bronchoscopy of where the unseen parts of a foreign body are in relation to the visible parts. The irregular, double, hook-shaped piece of metal was in the œsophagus of a girl aged three years. (Case No. Fbdy. 785). Both hook-shaped ends were buried in the œsophageal wall requiring special manipulations for the solution of disentanglement and safe removal. By comparing the schema, Fig. 14, it is seen that by placing the röntgenogram upside down all the relations correspond to those encountered at endoscopy.

and automatic as the use of knife and fork. The forceps are, mechanically speaking, a prolongation of the fingers. Their necessarily great length makes their use somewhat in the nature of walking on stilts. Special practice is necessary to acquire perfect control. This practice should be first on the rubber tube manikin and this practice should never be abandoned. It is what scales and exercises are to the musician.

The forceps should be held as in Fig. 8. This placing of the fingers can be memorized by the formula: "The ring finger in the ring." This position leaves the index finger free for pushing (always gently) on the stylet. When traction is necessary it is also made with the index finger in a mechanically correct manner, as shown in Fig. 9. It is for this use of the index finger that this forceps was designed. It gives a delicacy of touch transmitted through the most sensitive tactile member with which man is

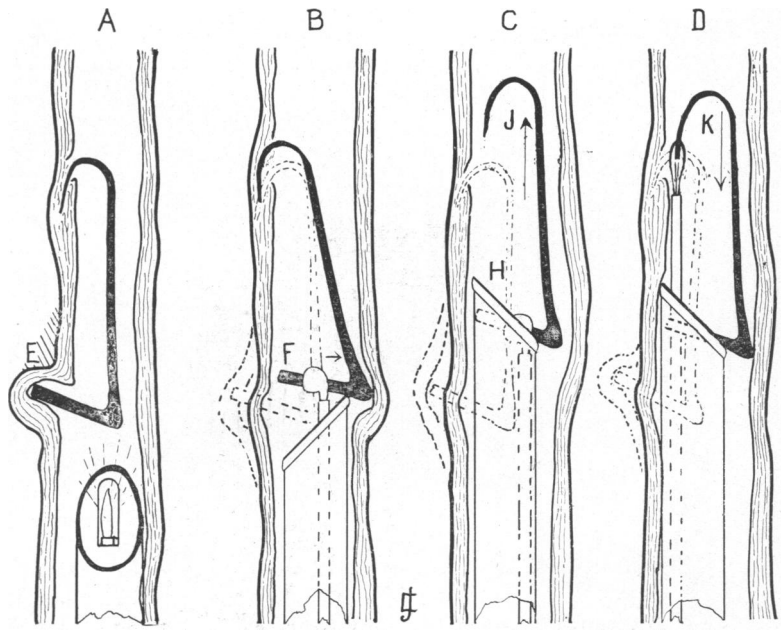


FIG. 14.—Schematic illustration of the problem of the double opposed hooks presented in the case illustrated in Fig. 13. The distal hook had penetrated the mucosa, while the proximal hook, E, was buried and locked in a fold above the cricopharyngeus (E) over which it was hooked. The removal was accomplished in six stages:

1—Manipulation of the proximal hook strongly in the direction of the dart, F.
2—Guiding the proximal hook down through the cricopharyngeal narrowing, E, so as to disengage the distal hook, J.
3—Pushing the œsophagoscope downward so as to repress the cricopharyngeal fold, E.
4—Placing the lip of the tube-mouth under the proximal hook, H, to prevent its catching during withdrawal.
5—Seizing the point of the distal hook, K, with forceps to prevent the point catching during withdrawal.
6—Withdrawal of the foreign body, the forceps and œsophagoscope together as one piece.

Time required: 9 minutes and 37 seconds. No anæsthesia was used and there was no trauma and no reaction. (Case No. Fbdy. 785.)

endowed. Forceps designed to do away with the springing upward, shown in Fig. 9, are like making a violin bow of cast iron so it will not yield. The parts of a forceps outside the tube can be made as heavy as desired and opening springs may be added; but when these things are done all delicacy of touch is destroyed.

The axis of approach of forceps is of the utmost importance, and especially so in case of foreign bodies with a more or less flat face occluding most of the area of cross-section of the bronchus. As will be understood from Fig. 10, a wrong angle of approach may make all the difference between the removal in a few minutes on the one hand, and on the other, not only

failure to seize the foreign body but pushing it down tightly into a position in the bronchus from which removal may be exceedingly difficult. Before insertion of the forceps the axis of the bronchoscope should always be brought into the position in which its axis corresponds to that of the invaded bronchus. If in doing this one edge of the field of view is obscured by the projection of the angle of the bronchial wall, the obtruding angle may be repressed with the lip of the bronchoscope. Usually all that is required is the rotation of the bronchoscope so as to bring the lip around to the obtruding sector. In the œsophagus axis of approach may increase those difficulties of proper grasp due to faulty presentation and lack forceps spaces, as illustrated in Fig. 4.

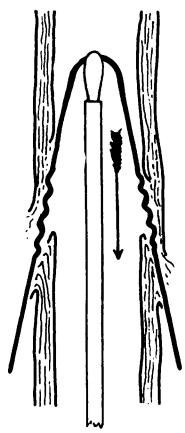


FIG. 15. — Schema showing how fatal trauma can be and has been inflicted by injudicious traction, in the direction of the dart, on a hair-pin lodged points upward in the œsophagus.

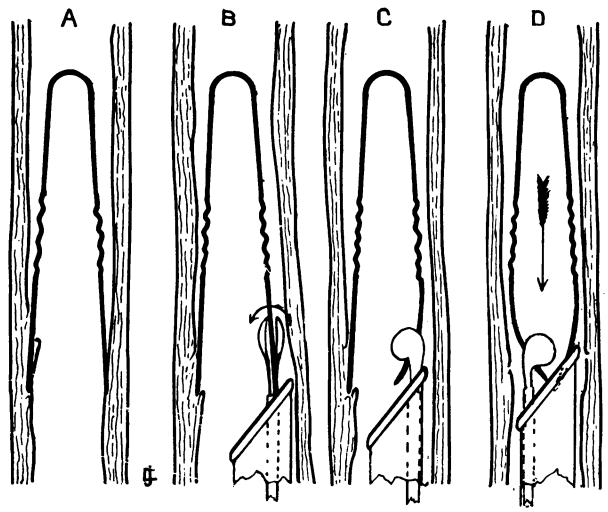


FIG. 16.—Schema showing how the danger shown in Fig. 15 was avoided by a carefully worked out solution of the mechanical problems involved. The points of an object like this have either penetrated the mucosa or penetration is imminent. First one point is turned with side-curved forceps (B, C); then the œsophagoscope (or bronchoscope) is pushed down so that the turned point rests on the lips of the tube-mouth while the other point is turned in. Thus protected, traction in the direction of the dart is safe. (Case No. Fbdy. 837).

Avoidance of inclusion of tissue in the grasp of the forceps is very important for three reasons: (1) Serious or fatal trauma may be inflicted by the laceration of blood-vessels. (2) Laceration of the bronchial wall may allow air and infective material to leak into the pleural cavity, producing a serious complication, or into the mediastinum, causing death. (3) Tissue between the forceps and the foreign body renders the grasp insecure. For these three reasons pulling upon a foreign body when tissue is included with the foreign body in the grasp of the forceps usually ends not only in failure to remove the intruder, but also in serious or fatal illness of the patient. See Fig. 11; also D in the color plate.

Safety-pins.—An open safety-pin, lodged point upward in the hypopharynx, is readily rotated with alligator forceps so that the point is in the

spatular tip of the laryngoscope which thus protects the tissues from laceration. The same method is ideal also in cases of laryngeally lodged safety-pins. In cases of deeper lodgment in either the œsophagus or tracheobronchial tree the pin may be similarly removed by flipping the point onto the lip of the tube-mouth or the pin may be closed or removed by the author's point-protected method [2] by which the pointed branch of the pin is brought as far as it will come into the tube-mouth. The pin, forceps and tube are then all brought out together, the keeper branch sliding upward harmlessly on the outside of the tube. Fig. 12 illustrates the method more clearly than the original illustration. This method will be greatly facilitated by the lips added to the side-curved forceps (Fig. 7). The chief difficulty encountered in the plan of

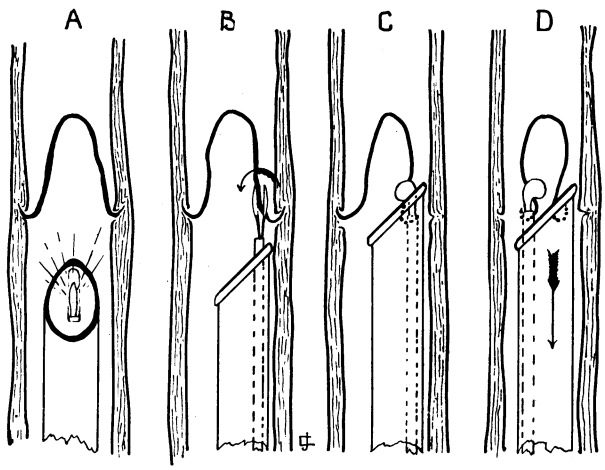
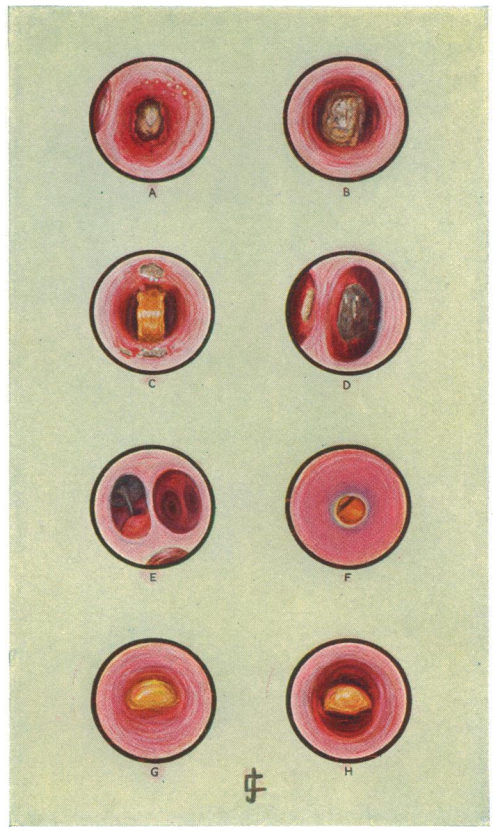


FIG. 17.—Schematic illustration of the method of disentangling a sharp-pointed, double, hook-shaped wire from an egg-beater that had lodged in the œsophagus of a woman aged 57 years, while eating custard pie. (Case No. Fbdy. 434.) The two hook-shaped sharp ends were buried in the mucosa (A). At B and C are shown the author's "outward rotation method" of disembedding buried points of any kind; in this case the wire being annealed the points were easily bent, one at a time, inward toward each other to get them into the tube-mouth for safe traction (D). The solution of the problem would be the same if the foreign body had lodged with the hooked ends downward. The method used in this early case has since been used many times in the Bronchoscopic Clinic for the removal of hair-pins, bent wire, etc.

getting the pointed branch into the tube-mouth was the tendency of the spring of the safety-pin to throw the pointed branch out of the grasp of the forceps. This the lips of Tucker's forceps prevent. These forceps make of my point-protected method the least difficult of all the plans of dealing with the open safety-pin. Closure and endogastric version are two excellent methods elsewhere described. Success and a reasonable degree of safety with any method of extraction of safety-pins lodged point-upward requires long preliminary practice on the rubber tube.

Rules for Röntgenographic Examination of Safety-pin Cases.—In dealing endoscopically with an open safety-pin, lodged point upward, the six most essential things to know beforehand are:

1. The size of the pin.



Endoscopic views illustrating mechanical problems encountered in cases of foreign bodies in the lungs. A. Foreign body (a bone) impacted in a bronchus so tightly that no forceps-spaces existed Before admission prolonged fruitless efforts under general anæsthesia had been made to grasp the foreign body without realization of the impossibility of doing so in the absence of forceps-spaces. The inflammatory areola shows where the mucosa had been punched with the opened forceps. B. Same patient as in A after I had created lateral forceps-spaces by withdrawing the foreign body to a higher level with a hook. Forceps were then readily applied and the foreign body was easily removed. C. Mucosal trauma inflicted by the attempt to force forceps jaws onto a foreign body sagittally where no forceps-spaces existed, ignoring good lateral forceps-spaces. D. The trauma, indicated by the inflammation, the swollen dividing-spur and the patch of exudate on the mucosa of the left-hand orifice, was inflicted before admission by the faulty attempt to grasp the foreign body seen in the right hand orifice. The inclusion of the dividing-spur is easily avoided by the method shown in the schematic illustration, Fig. 11. My predecessor in the case stated that he had grasped the foreign body and had pulled as hard as he dared. As the foreign body was free to move it is certain the traction was being made upon forceps that included tissue as well as foreign body. E. Endoscopic view in the lower-lobe bronchus showing a tack that, before admission, had been injudiciously pulled upon without first disengaging the point. Release of the point by the author's outward rotation method after pushing the tack downward resulted in a prompt and safe removal. F. Annular edematous (not fibrous) stenosis from the trauma inflicted before admission, in jamming the foreign body (a screw) down in a bronchus, in a faulty effort to grasp the screw-head in the absence of forceps-spaces. On admission only a tiny portion of the screw-head was visible and the situation of the slot or fillister indicated a slight tilting of the screw. The problem in this case was solved by withdrawing the screw to a new position above the edematous area with the closed side-curved forceps used as a hook. The same forceps were then used in the usual way to grasp and remove the foreign body. G. A peanut kernel in the bronchus of a child. During expiration, as here shown, no forceps-spaces existed because of the collapse of the bronchial walls during this phase of the respiratory cycle. H. Immediately upon the beginning of inspiration the bronchial walls recede from the peanut kernel, creating large forceps-spaces between it and the bronchial walls. In the case here illustrated the spaces are located anteriorly and posteriorly. It is early during this inspiratory stage of respiration that the forceps must be placed. The here-shown phenomenon of the opening and closing of the forceps-spaces in respiration is the mechanism by which air is trapped in the invaded lung or lobe, producing the obstructive emphysema that is diagnostic of the presence of a peanut kernel in the lung. In this case Dr. Willis F. Manges had made a diagnosis of non-opaque foreign body, probably peanut kernel, in the right bronchus, in the absence of a history.

1. The size of the pin.
2. The greatest spread from the point to the keeper.
3. The exact plane of this greatest spread.
4. The direction of the point.
5. The precise location of the point, the keeper and the spring.
6. The degree to which each of the two branches of the pin deviates from the vertical axis of the patient's thorax.

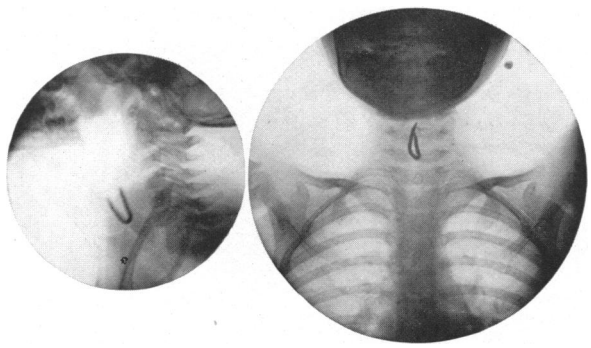


FIG. 18.—Röntgenograms, anteroposterior and lateral, showing staple in the subglottic trachea of a girl, aged 4 years (Case No. Fbdy. 825). Removed laryngoscopically through the mouth by cephalic version, in one minute and thirty-five seconds, without anæsthesia, general or local. The illustration also shows the necessity of the ray study in two planes. The lateral view conveys no idea of the complicating curves and divergent points that it was necessary to know in order to accomplish the version. Plates made by Dr. Willis F. Manges.

7. Bends, breaks, kinks or other imperfections of the pin.

More failures safely to remove safety-pins have resulted from lack of a properly preconceived mental conception of all of these data as to the particular case than from any other one cause. All of these data can be supplied

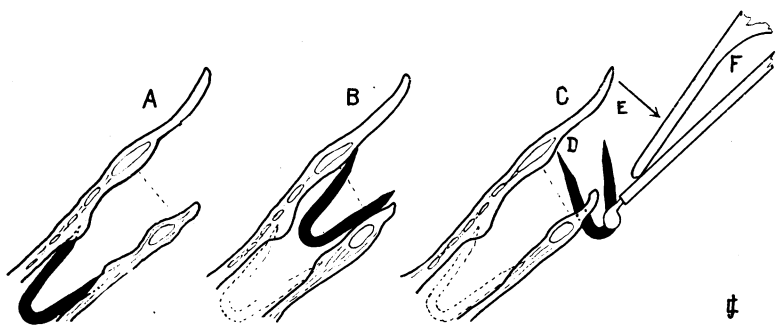


FIG. 19.—Illustrating the solution of the problem of the staple, with buried points, in the case illustrated in Fig. 18, by posterior version (C). The turning was done after working the staple upward, one point at a time (B), always guarding the advancing point. The trailing point (D) has no tendency to puncture. The laryngoscope (F) is exerting pressure (E) on the forceps in a posterior direction to complete the version.

by the röntgenologist. To get these data one plate at least should be free from foreshortening. With these data and a duplicate of the pin the trained bronchoscopist can in a few hours with his bronchoscope or œsophagoscope and a bit of rubber tubing work out the problem in such a way as to make him feel sure of safety and success in dealing later with the patient. The

working plates in the operating room should include a lateral, an antero-posterior and one free from foreshortening.

Irregular Metallic Objects.—The varieties of these are numerous; but the general principles of the solution of the problems of extraction are the same. A careful ray-study in all planes is made to ascertain the dimensions of the foreign body and the planes in which the greatest and least dimensions lie. Then a study is made to determine the position of points, rough places, hooks, angles or any other potentially traumatizing characters of the foreign body. A plan is next worked out, first in theory, then on the rubber-tube

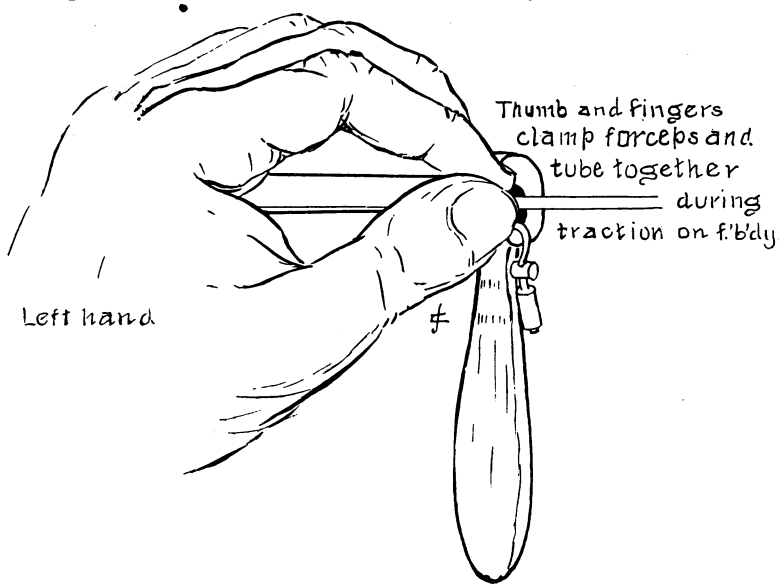


FIG. 20.—In order to avoid the lagging behind of the foreign body (see Fig. 21) and to insure the movement together of the foreign body, the forceps and the bronchoscope, all as one piece, the left hand should be used as here shown to clamp the cannula of the forceps against the proximal tube-mouth while traction is being made. The left hand should make all the traction, the right hand simply moving along passively while making the necessary degree of compression on the forceps handles. This method applies to the removal of any and all foreign bodies that are too large to be withdrawn through the tube.

manikin, by which hooks are disengaged, points guarded, rough places turned or held away during withdrawal so as to avoid trauma. A good illustration of the method of working out these various problems, or combinations of problems, is shown in Figs. 13 and 14, and will be understood from reading the legends.

Hair-pins and Bent Wires.—These cases are similar to the staple in that the points become buried (Fig. 15 and Fig. 17), but they differ in that the wire is of smaller gauge and is annealed, hence is easily bent. The fence staples are of rigid wire that cannot be bent or cut by any instrument that can be used through a bronchoscope.

The wire from an egg-beater was quickly and safely removed by the method shown in Fig. 17.

The hair-pins were removed by the method illustrated in Fig. 16. Being

of stiffer wire a forceps of different shape facilitated the bending of the points.

Fence Staples.—The surpassing difficulty in dealing endoscopically with these objects when encountered points upward, as they usually are, arises from their construction. In order to be driven into wood the points are made very sharp and the steel is very rigid. The points are spread and they rip in upon the slightest effort at traction. The wire cannot be cut or bent with any instrument slender enough to go through a bronchoscope. The method of cephalic version by which the author first solved the exceedingly difficult problem, presented by these foreign bodies when they are lodged point upward,[4] has proven entirely satisfactory in seven subsequent cases,

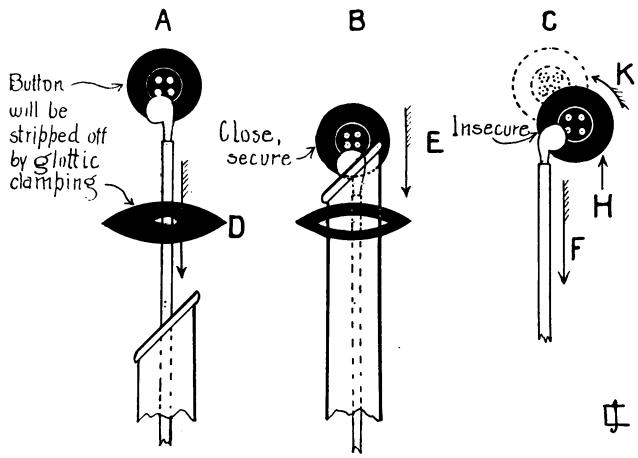


FIG. 21.—Illustrating the necessity of keeping the foreign body close to the tube-mouth during withdrawal so as to emerge with the tube (B). If allowed to trail as shown at A it will be stripped off the forceps by the glottis (D) clamping tightly around the stem of the forceps. This applies to the endoscopic removal of all foreign bodies too large to be brought out through the tube. In œsophageal work the cricopharyngeus will strip off the foreign body in the same way as the glottis does at bronchoscopy. Therefore, D, in the schema above may be taken to mean either glottic or cricopharyngeal clamping. At C is shown the fault of the one-sided grasp of any foreign body in endoscopic removal. When traction is made in the direction of the dart, F the resistance of any tissue encountered (H) by the sidewise projecting portion of the button will cause the button to be rotated in the direction K, inevitably loosening it from the grasp of the forceps. (See also Fig. 33.)

in all of which the staple was removed without mortality. The essential thing to remember in turning or otherwise manipulating these objects is that the trailing point does no harm, whereas the advancing point will rip in unless it is watched and the tissues are safely guarded. In a recent case (Fbdy. No. 825) of a staple in the trachea of a girl, aged four years, the points were found buried in the swollen subglottic tissues below the anterior and posterior commissures, respectively, the greater plane of the staple being sagittally lodged (Fig. 19). The posterior point was readily seized and advanced up out of the larynx, the anterior point being caused to trail downward as the curved head was brought upward. The head was then gently forced posteriorly against the soft-tissue wall which yielded enough to permit version. For success with staples it is essential to have beforehand

a mental conception of the staple in all its relations. For these the ray-study should be made to determine:

1. The exact length of the staple free from foreshortening.
2. The extent of the spread of the staple from point to point.
3. The plane of the greatest spread.
4. The location of the staple.
5. The degree of divergence of each of the two branches of the staple from the parallel.
6. The form, size and axis of the bronchi in the neighborhood, as shown in stereoscopic plates. If necessary, the author's method of lung-mapping by the insufflation of bismuth may be used to increase the visibility of the bronchi.

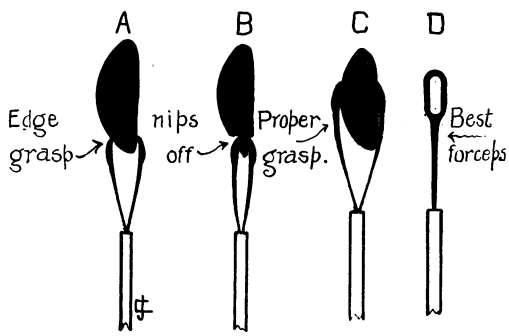


FIG. 22.—Illustrating the right and wrong ways of grasping peanut kernels and all other friable substances. If the forceps are applied close to the presenting edge (A) a fragment of the edge will be nipped off (B). With proper forceps and a gentle hand the peanut kernel will not be crushed if grasped over the minor axis, as shown at C. The author's special peanut forceps (D) have proven very satisfactory. The long soft spring of the jaws as well as the fenestra and the springless handle all contribute to gentleness of grasp with sufficient holding power.

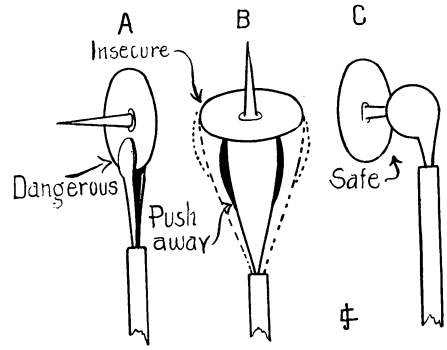


FIG. 23.—The problem of the thumb tack. If grasped as shown at A, serious and if in the œsophagus, fatal trauma will be inflicted during removal. If the flat face of the head presents, as at B, the attempt to apply the forceps will push the intruder into a lower and more difficult position; and even if the forceps were gotten over the periphery of the disk-like head as shown by the dotted lines (B) the hold would be very insecure. If the stem of the tack is grasped as at C, the hold will be secure and, most important, the point will be covered so as to protect the tissues from trauma. All other presentations should be converted into this one (C) by version with the forceps and the lip of the tube-mouth used coördinately.

Peanut kernels and similar friable substances, such as beans and maize, require great delicacy of touch. So exacting is this requirement that it is my rule when a series of cases at a clinic included a peanut case, always to take it first in order that delicacy may not be obtunded by any preceding work. Peanut kernels are especially friable, the friability varying with the degree of roasting and to a less extent with the degree of maceration. To crush a peanut kernel in the bronchus of a child is apt to cause multiple abscesses from the scattered aspiration of minute fragments that cannot afterward be found. This is a disaster to avoid which the utmost caution should be taken, while endeavoring to hold the peanut sufficiently securely to prevent its being stripped off at the glottis. For these friable substances I have used for years a fenestrated forceps; but have recently added to my equipment for this purpose an extremely delicate model of the plain grasping

forceps. The jaws are very thin, as befits the small forceps spaces usually available in these cases, and a very soft spring permits of the utmost delicacy of touch. Great strength is not necessary and these forceps are carefully kept for this particularly delicate work in which they have given the utmost satisfaction. Like all other forceps they should have a covering-clamp slipped on over the jaws to keep them closed and protected when not in use, so that the jaws will not get bent backward. All forceps should be well oiled in their cannulæ before putting away. Reliability in instruments depends largely upon their care. With the very delicate forceps needed to feel a peanut kernel a well cared for instrument may make all the difference between sending the baby home well in a few days and sending him home in

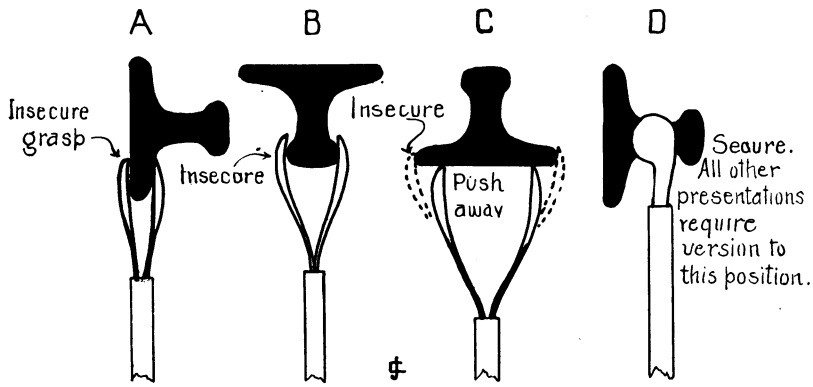


FIG. 24.—The various unfavorable presentations of the collar button and how they are converted into favorable presentations by version. At A is shown a very insecure hold; the collar button is certain to be stripped off at the glottis. At B is shown another insecure hold. In the presentation, C, it is almost impossible to grasp the collar button and the attempt is likely to push the button into a deeper and more difficult position. Even if the forceps were expanded to the position of the dotted lines the hold would be very insecure because of the tendency to tilt. At D is shown a very secure hold and in this position the collar button meets least resistance in withdrawal. All other presentations should be converted into this one by manipulation with hooks, or preferably side-curved forceps, and tube-mouth worked coördinately as knife and fork.

a box. With a delicate forceps well oiled and working smoothly in his possession the man who expects to be successful in removing peanut kernels without crushing them should crush a few quarts of peanut kernels tc acquire the sense of tactile differentiation between the degree of forceps-pressure necessary securely to hold a peanut kernel during its withdrawal through the glottis and the degree of pressure that will crush it. This is a purely manual thing to be acquired only by feeling the peanuts crush and then feeling others against the tube-mouth while being withdrawn. Knowledge of how to do it is not enough. The problem is simulated for practice by inserting half of a peanut kernel in a piece of rubber tubing so small that it fits tightly. Then working through the infant size bronchoscope the forceps spaces are found, the forceps placed, and the peanut is withdrawn until it is felt to meet the distal tube-mouth. Then the forceps are clamped against the side wall of the proximal tube-mouth with the fingers (Fig. 20) so as to fix the tube, foreign body and forceps, together as one piece during with-

drawal. This method minimizes the likelihood of having the foreign body stripped off at the glottis as shown in Fig. 21. Much practice is necessary to execute this manœuvre with soft friable bodies like peanut kernels. If pulled too strongly against the tube-mouth they will be stripped off, or worse, crushed by the tube-mouth forcing the forceps shut. One great fault I find in pupil physicians at the Bronchoscopic Clinic is the nipping off of the peanut kernel by an insufficient grasp. If the forceps close on the equator of the

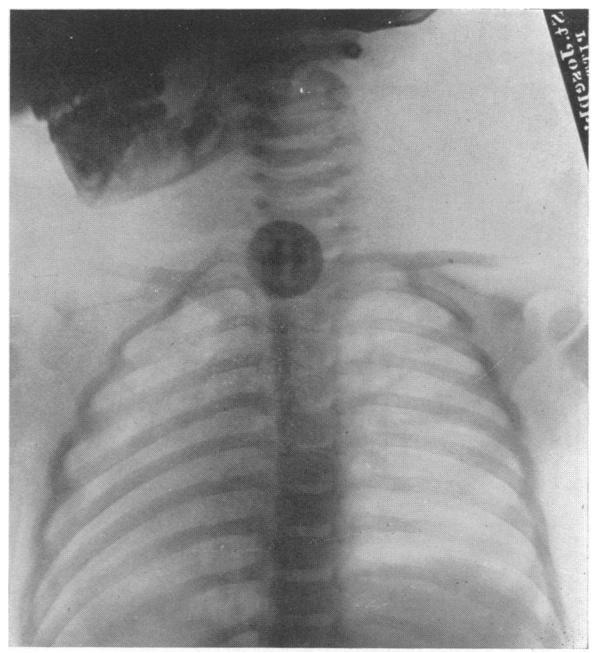


FIG. 25.—Most buttons, occurring as foreign bodies today, being made of casein, do not show. This one, of a denser composition, pearl shell, shows clearly. The mechanical problems of removal of buttons are illustrated in Figs. 21 and 26.

peanut kernel, crushing is much less likely than if the edge only is grasped (Fig. 22).

Grains of Maize usually present the germ-end the center of which is soft. If this germ is grasped it will come away leaving the "mouse gnawed" grain behind. To prevent this the grain should be grasped as shown at C, Fig. 22.

Tacks, pins. needles and similar pointed objects present problems the solution of which I described years ago.[1] These solutions have stood the test of many cases and have never failed to yield results. One great aid in the execution of these manipulations will be the new Tucker modification of the side-curved forceps (Fig. 7). The little projecting lips prevent the shaft from slipping out of the grasp of the forceps.

Collar Buttons.—The many different positions in which a collar button can present itself makes it an ideal object for practice on the rubber tube.

It is a typical example of the value of version in converting an unfavorable presentation into a favorable one for grasping and removal, as illustrated in Fig. 24.

Thumb tacks present a different problem from other tacks. They also present a good illustration of how a foreign body potentially dangerous may be safely and easily removed. The dangerous and the safe ways are illustrated in Fig. 23.

Very large foreign bodies in the œsophagus present difficulties that have defeated many œsophagoscopists, some of whom have gone so far as to say that external œsophagotomy with its relatively high mortality is justifiable. This I feel sure is a mistake, apart from the fact that it, in any event, could only apply to foreign bodies high in the œsophagus. Formerly I thought it

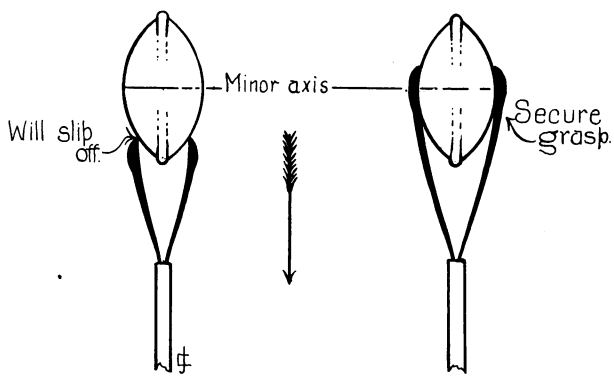


FIG. 26.—The problem of the thick, hard, smooth-surfaced foreign body of conoidal cross-section, illustrated in this instance by an ellipsoidal button. If grasped near the vertex, the forceps will slip off as soon as traction is made in the direction of the dart. To get a secure grasp, the forceps jaws must be placed beyond the minor axis of the ellipsoid, or base of the conoid, as the case may be. With spheroidal bodies, the jaw should go beyond the equator.

necessary in cases of œsophagoscopy for very large and sharp foreign bodies to relax the patient by ether anæsthesia to prevent trauma by the clamping of the foreign body by the œsophageal musculature. This I have found to be rendered quite unnecessary by the hereinafter-mentioned manipulations. Because of the development of this technic also, I have never yet had to resort to morcellation and fragmentary removal of any foreign body because of its size, though preparations for doing so have always been made. If anyone should desire to cut a foreign body it might be well to use the bouginage œsophagoscope because the increased lumen obtained by putting both the drainage and the light canals outside of the wall of the tube permits the use of large, heavy shears. Such a procedure as morcellation introduces special dangers to the patient. I have always, so far, found that any foreign body that has gone down the œsophagus could be brought back the same way, provided certain requirements are fulfilled. To have seized the large intruder with powerful forceps and dragged it out by main strength would undoubtedly have been fatal in many cases. Three precautions are necessary for safety

and success in the author's method of œsophagoscopic removal of very large foreign bodies by rotation and tubal manipulations:

1. Very careful preliminary ray-study is necessary to determine the location of any sharp corners or edges, any concavities, hooks, or other possible characters that might impede removal or cause trauma, so that such potentially traumatic factors can be eliminated by version or otherwise.

2. The largest possible œsophagoscope must be used so as to hold the œsophageal walls well spread apart during withdrawal. The œsophagoscope

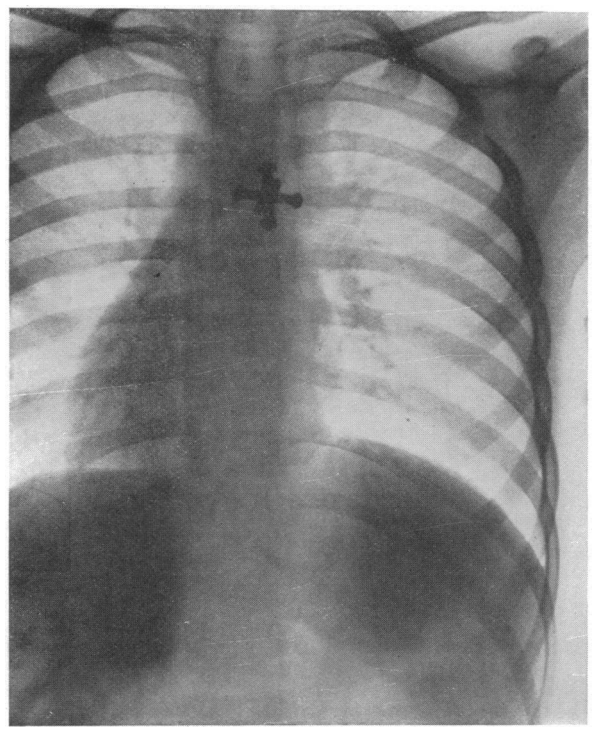


FIG. 27.—Toy jack in the œsophagus. Removal presented the problem the solution of which is illustrated in Fig. 28.

must have the regular slanted end, so as to afford the advantage of the lip in the tubal manipulation of the folds.

3. The foreign body must be brought up in the position of least resistance, doing a partial or complete version if necessary for the purpose. Rotation forceps are usually the most serviceable instruments for this purpose.

4. The foreign body must be kept close up to the tube-mouth during withdrawal for three purposes: (*a*) To keep the foreign body in the space of widely separated walls in the wake of the tube-mouth, (*b*) to keep the foreign body in view all the way up so as to enable the œsophagoscopist to carry out tubal manipulation of the collapsing folds, (*c*) to minimize the clamping of the intruder by the collapsing folds.

5. A close watch for collapsing walls and clamping folds must be maintained and these must be controlled by manipulation with the lip of the slanted tube-mouth.

These methods have enabled me to remove œsophageally lodged foreign bodies in 238 consecutive cases without resort to external œsophagotomy in any case.

Hard, Smooth Conoidal Bodies are best dealt with as shown in Figs. 25 and 26.

Toy Jacks are managed as shown in Figs. 27 and 28.

The Upper-lobe Bronchi are rarely invaded, but in their proximal portions a foreign body is readily dealt with. When their ascending branches are invaded the difficulties of work are very great, as shown in Figs. 29, 30 and

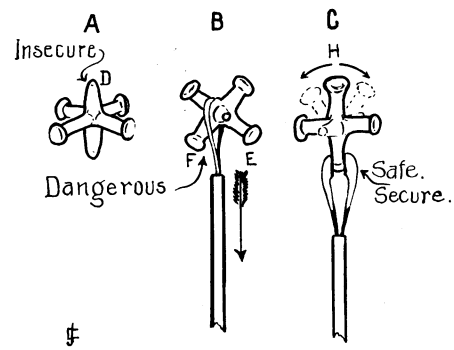


FIG. 28.—The problem of the toy jack in the œsophagus. The plain points, D, afford a very insecure grasp. The grasp with rotation forceps, B, is very secure but in this grasp the points E and F have a hook-like action similar to a graefe basket and are sure to injure the œsophageal wall by catching in a fold. The most secure grasp, and the one that should always be obtained, by version if necessary, is with a cupped forceps applied to one of the ball-points. This grasp permits wobbling (H) which permits the other points of the jack to free themselves from the fold encountered during withdrawal in direction of dart. In some cases assistance by rotation with the forceps and tube-mouth is needed to free the points.

31; but they have been to a certain extent overcome by methods being developed in collaboration with Dr. Willis F. Manges.

Magnetic Extraction of Foreign Bodies.—One of the most frequently asked questions is in regard to the usefulness of magnets in cases of foreign bodies in the lungs. There have been no developments since our report.* The limitations arise from the small size of the foreign bodies and the fact that they are not free to move. The smaller the foreign body the less the magnetic attraction. If an iron or steel foreign body were the size of a sledge hammer it could be pulled out through the chest wall. The only case in which a magnet could possibly be desirable would be that of a tiny iron or steel foreign body in a branch bronchus so small that a bronchoscope could not enter, and these are precisely the cases in which magnets are useless. Inasmuch as we have now developed methods of removing all of these, as all other kinds of foreign bodies with forceps or other instruments, it would seem that magnetic extraction is not needed. Moreover, in using a

* Jackson, Chevalier: The Laryngoscope, April, 1905.

magnet there is no control over the position of the foreign body in relation to the bronchi invaded or to be traversed in extraction. Hence all the niceties of disentanglement and version are impossible. However, all experiment, if not carried out on living human subjects, should be encouraged. The author hastens to add that these are only his personal views.

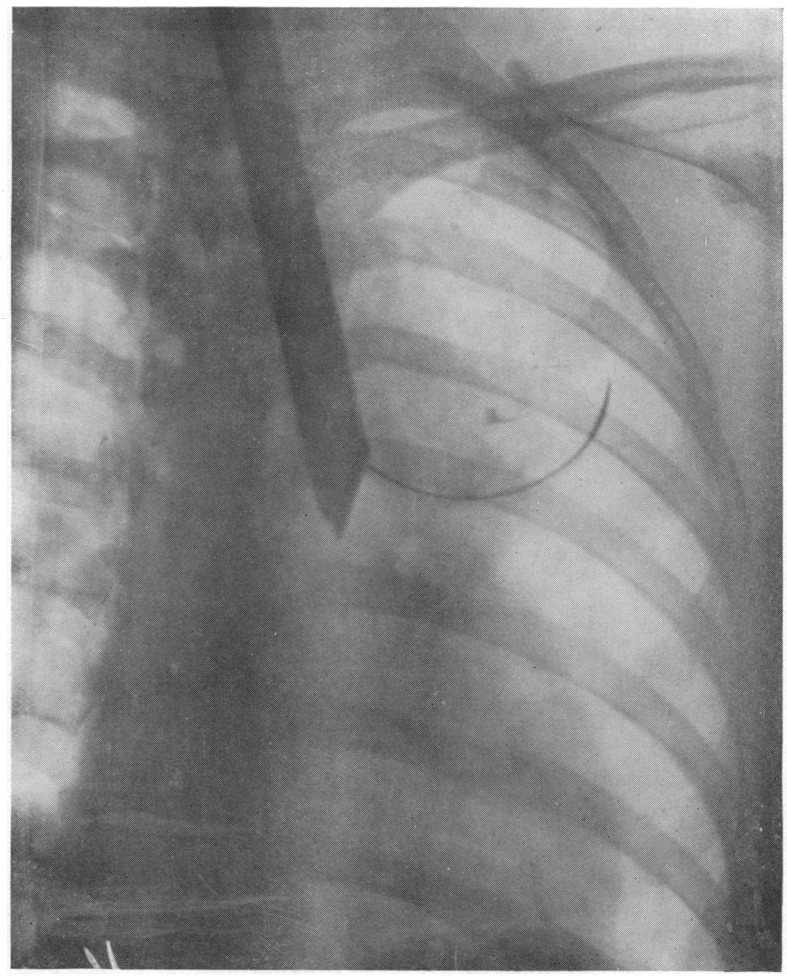


FIG. 29.—Röntgenogram showing a coil spring hook reaching "around-the-corner" into an ascending branch of the upper lobe bronchus of a patient. The hook went beyond the foreign body because this particular coil-spring was of too long a radius of curvature. This plate was made by Dr. Willis F. Manges, whose aid in the development of upper-lobe-bronchial work is gratefully acknowledged by the author.

CONCLUSIONS

In all cases of bronchoscopic and œsophagoscopic foreign body extraction the fundamental rule should be the avoidance of risk of mortality. Most of the operations in surgery are bimanual binocular procedures, whereas foreign-body endoscopy is a monocular, depth-gauging procedure handi-

capped by limitations due to the smallness of the bronchi and the length and slenderness of the instruments. Differing thus from all previous training of the operator, safety and success require eyes and fingers that have been trained to the work. It is impossible, to say nothing of the inhumanity of the attempt, to get this training by work on patients. The time is insufficient. Hundreds of hours should be spent in educating the eye and the fingers with the bronchoscope working with all kinds of foreign bodies in a rubber tube, a cadaver and a living dog. Then when a case comes along a few hours preliminary working in the same way with a duplicate foreign

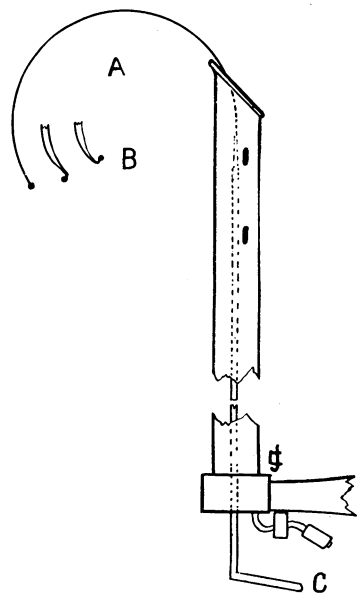


FIG. 30.—Coil-spring hooks for reaching "around-the-corner" into the ascending branches of the upper-lobe bronchus. They are straightened in their passage through the bronchoscope, resuming their curve after emergence. The degree to which this emergence is permitted regulates the distance of entrance into the upper-lobe and, to some extent, the radius of curvature; though hooks of different spring-radii are provided. The hook, proper, at the extremity (B) does not exceed a right angle in its bent position. Hooks are made in various directions, but the two illustrated (B) have the advantage that, if caught, they can be disengaged by manipulation of the handle (C).

body will provide the bronchoscopist with an experience such as he could not obtain from even hundreds of cases. If this plan of preliminary general practice followed by special practice for the particular case be conscientiously carried out, I feel sure that any foreign body that has gone down the natural passages can be brought up the same way, provided the following rules for the use of forceps or other extracting instruments are followed:

RULES FOR USE OF FORCEPS

The following rules are those formulated by the author for his own use. Hence they are stated dogmatically. The terms "must" and "should" refer only to what the author says to himself. Each operator can modify them to suit his own personal experience or equation. For convenience the

term bronchoscope is used. Almost all of the rules apply with equal force to the œsophagoscope, the œsophageal speculum and the direct laryngoscope:

1. Before insertion of forceps the long axis of the bronchoscope must be brought to correspond with that of the bronchus invaded by the foreign body.

2. The size and kind of forceps most suitable must be determined before introduction of the forceps.

3. The plane of expansion must be determined before the insertion of forceps.

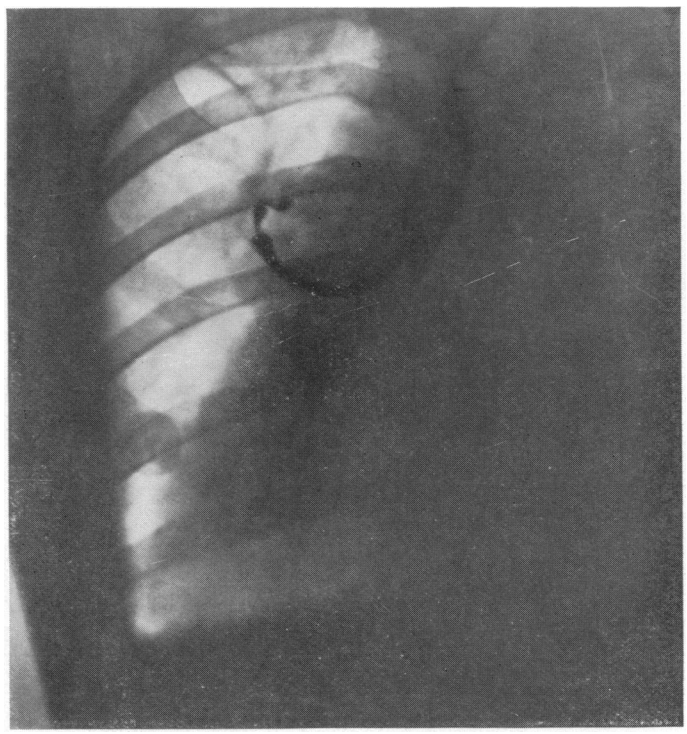


FIG. 31.—Röntgenogram showing the spiral, upper-lobe bronchus forceps extending around 180 degrees in an ascending branch of the upper-lobe bronchus. Though apparently in contact with the foreign body, the forceps are in a bronchial branch about 2 cm. anterior to the foreign body. Plate made by Dr. Willis F. Manges.

4. The plane of expansion must be determined by the greatest plane of the intruder, the shape of the presenting part and the position of the forceps spaces.

5. There must be two forceps spaces, if two-jawed forceps are to be used, and they must be on opposite sides of the foreign body. If only one exists another must be made by manipulation of either the intruder or the tissues, normal or pathologic, or by working the intruder upward into a wider passage. If none exists two must be created.

6. Before applying forceps an unfavorable presentation must be converted into a favorable one by

(*a*) Creation of forceps space or spaces if only one, or none, exists.

(*b*) Partial or complete version if required for disentanglement, disimpaction, disengagement of a point, or proper presentation for seizure.

7. Great care is necessary to avoid seizing tissue along with the foreign body. In the œsophagus a fold of the collapsing walls, or the cricopharyngeal fold; in the bronchi the spur between bronchial orifices, or even a duplication of the bronchial wall may be included in the grasp of the forceps. To pull, tear or twist with forceps so engaged usually means the death of the patient. If only the mucosa is nipped, fatal injury may not be inflicted, but the prolonged oozing of blood will diminish visibility by obscuring the field and by tinting the surface of the foreign body.

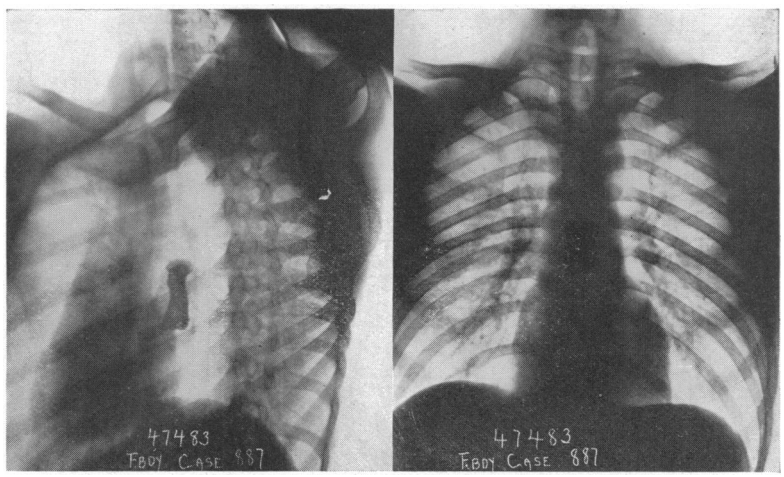


FIG. 32.—Röntgenograms anteroposterior and lateral, of a man aged 28 years (Case No. Fbdy. 887). Showing a very large artificial denture in the œsophagus which before admission could not be pulled out of the œsophagus. Removed through the mouth by œsophagoscopy without anæsthesia in 2 minutes and 11 seconds by the method illustrated in Fig. 33. Plates made by Dr. Willis F. Manges.

8. Traction should never be made until it is certain that the foreign body can be withdrawn without trauma to the tissues.

9. No matter how sure you are that the foreign body is properly seized and free to be withdrawn, never pull strongly enough to tear tissues apart. The safe degree of traction can be determined by the tactile sense trained by experiment on the cadaver.

10. In many instances traction must be preceded by pulsion, or by rotation, or by both, according to the mechanical problem present, in order to free a foreign body or its point.

11. When dealing with a pointed object, no traction should be made until the point is in the tube-mouth or is otherwise protected.

12. The index finger, being keenest in sense of manipulative touch, should be used for traction and propulsion of forceps. To leave it free the middle and ring fingers are inserted in the rings of the forceps.

13. In case of foreign bodies that cannot be withdrawn through the bronchoscope or œsophagoscope, the foreign body must be held closely against the distal tube-mouth by traction on the forceps until the resistance of contact is felt. Then the cannula of the forceps is firmly fixed against the side of the lumen of the proximal tube-mouth as shown in Fig. 20. This clamps the

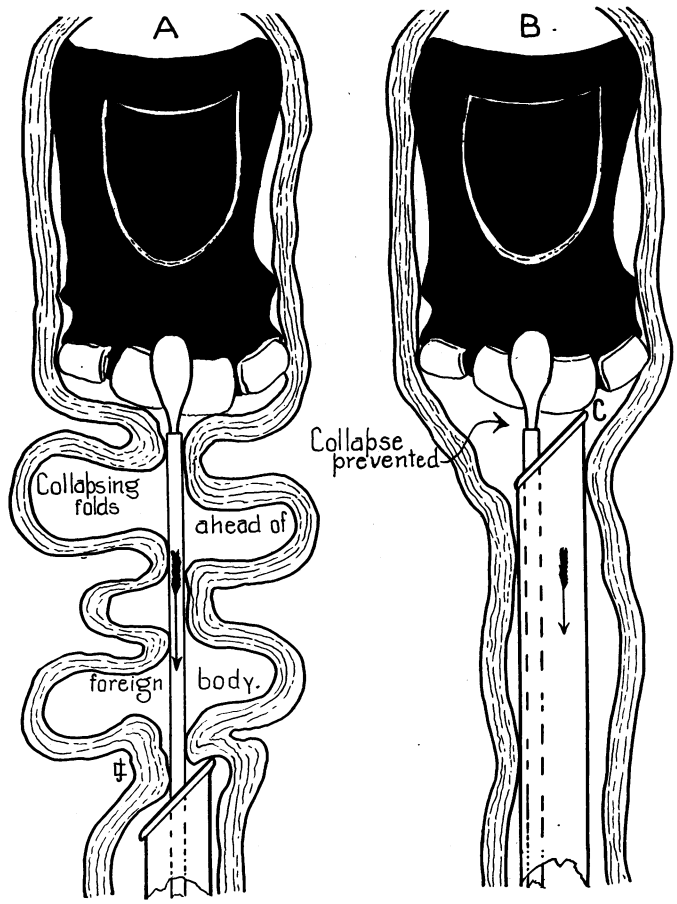


FIG. 33.—Schematic illustration of the author's method of dealing with foreign bodies of very large size in the œsophagus. In this particular case (see Fig. 32), selected for illustration, œsophagoscopy prior to admission failed because nothing short of fatal traction could bring the artificial denture through the obstructing folds (shown in illustration A), which had been allowed to collapse in around the forceps by withdrawing the œsophagoscope at a higher rate of speed than that of the forceps and foreign body. By bringing œsophagoscope, forceps and foreign body all out together as one piece, the foreign body close against the tube-mouth (B), a heavy collapse of folds is impossible. Any fold that catches the foreign body can be readily manipulated out of the way by the tip of the tube-mouth. See also Figs. 20 and 21.

three elements, foreign body, bronchoscope and forceps, together as one piece, so that all come out together. If this is not done the foreign body trailing beyond the tube-mouth, as it is almost certain to do if each instrument is held independently, will permit glottic closure on the forceps cannula before

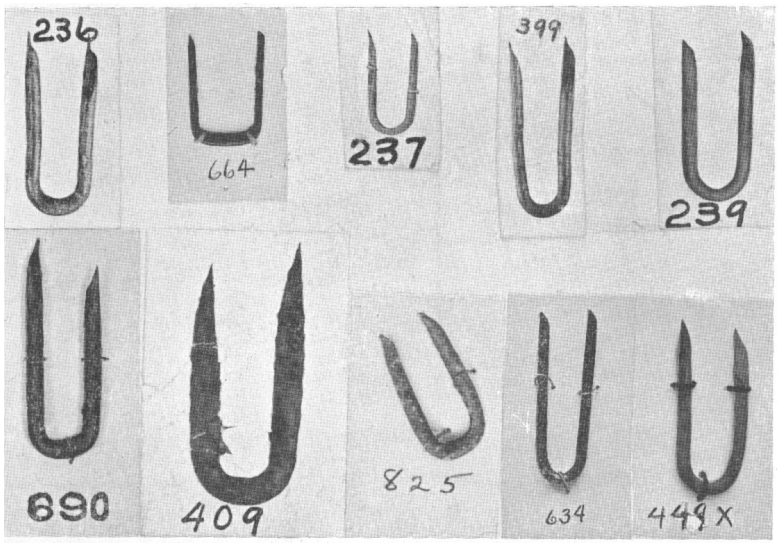


FIG. 35.—Staples endoscopically removed from the air and food passages. Foreign body No. 825 was removed by posterior laryngeal version. All the others were removed by endobronchial or endœsophageal cephalic version. That is, the sharply pointed presenting extremities were turned back so that the staple could be safely withdrawn head first.

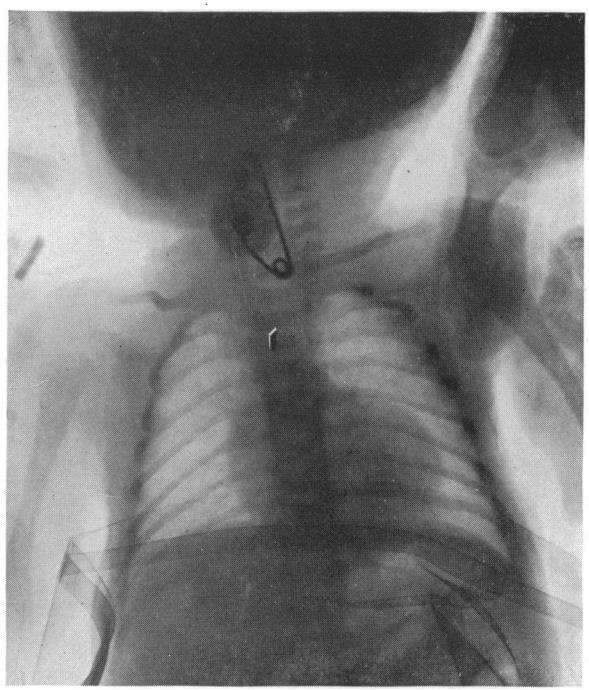


FIG. 36.—The safety-pin problem complicated by a button. The button and pin had been swallowed together; the metallic ring of the button was on the pointed branch of the pin; the entire foreign body mass being anchored by the point of the pin having perforated the œsophageal wall and having hooked itself under the tightly contracted cricopharyngeus muscle. The keeper end of the pin was in the post-cricoidal pharynx. The difficulties were increased by the size of the patient, an infant aged 10 days. The problem was solved and the pin was removed in one minute by the method illustrated in Fig. 12.

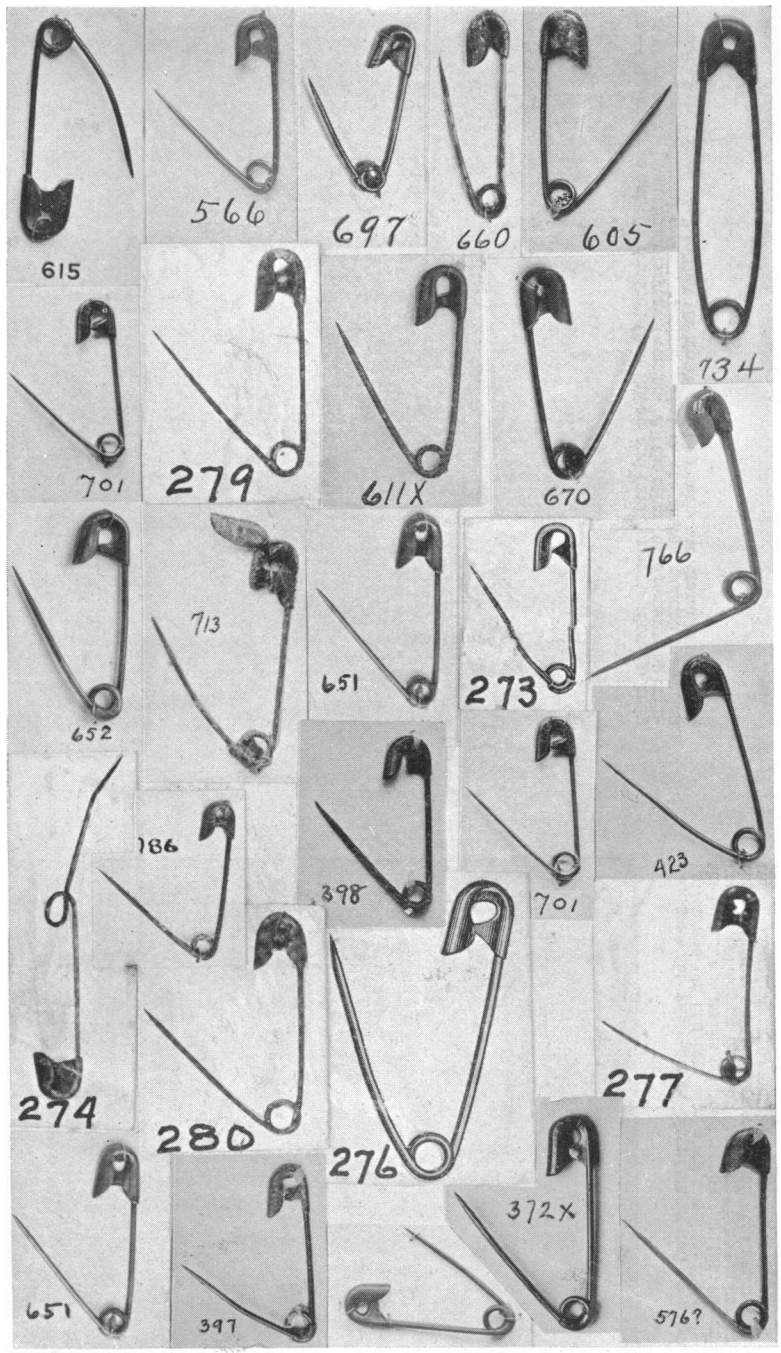


FIG. 37.—Some of the safety-pins removed from the air and food passages, at the Bronchoscopic Clinic by endoscopy through the mouth, without anæsthesia. Some of the open pins were closed before removal, others were removed by the point-protecting method, and still others were removed by endœsophageal or endogastric version.

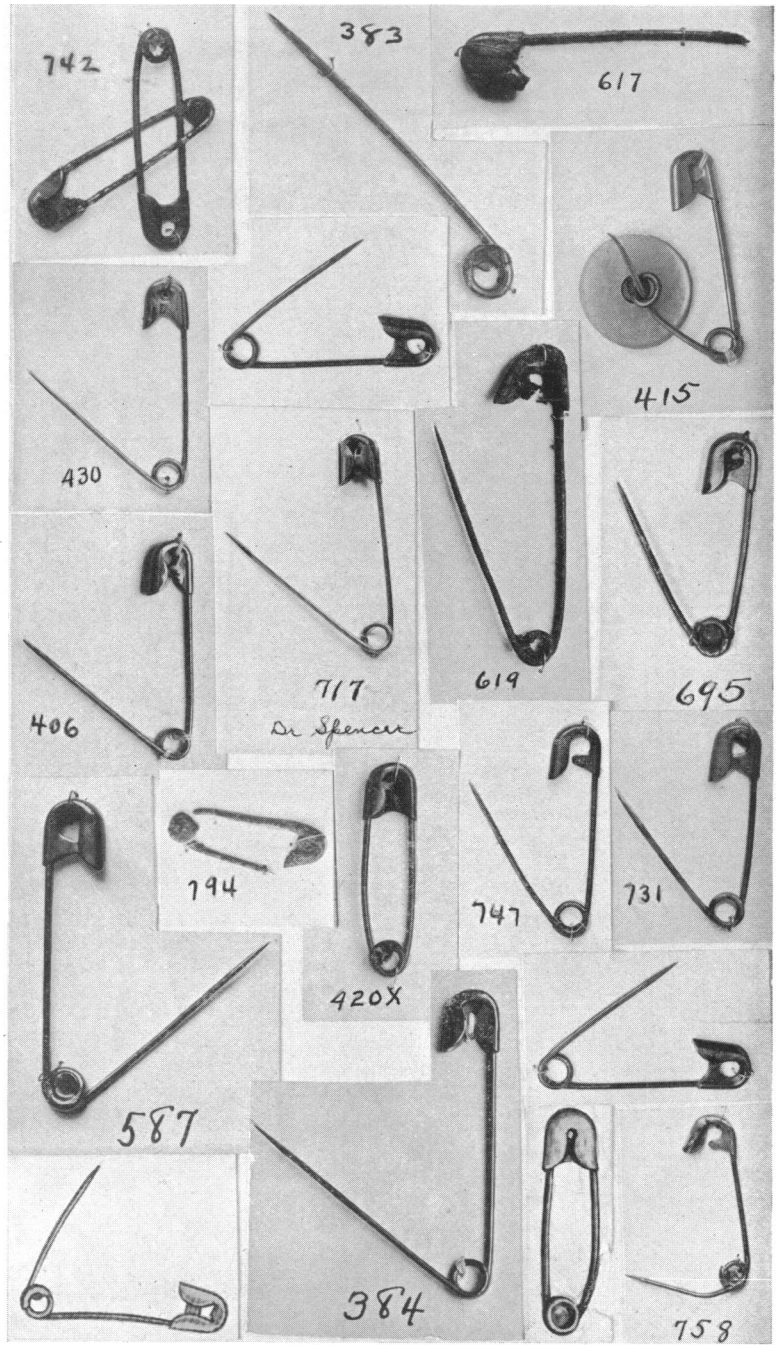


FIG. 38.—Some of the safety-pins removed from the air and food passages, at the Bronchoscopic Clinic by endoscopy through the mouth, without anæsthesia. Some of the open pins were closed before removal, others were removed by the point-protecting method, and still others were removed by endœsophageal or endogastric version.

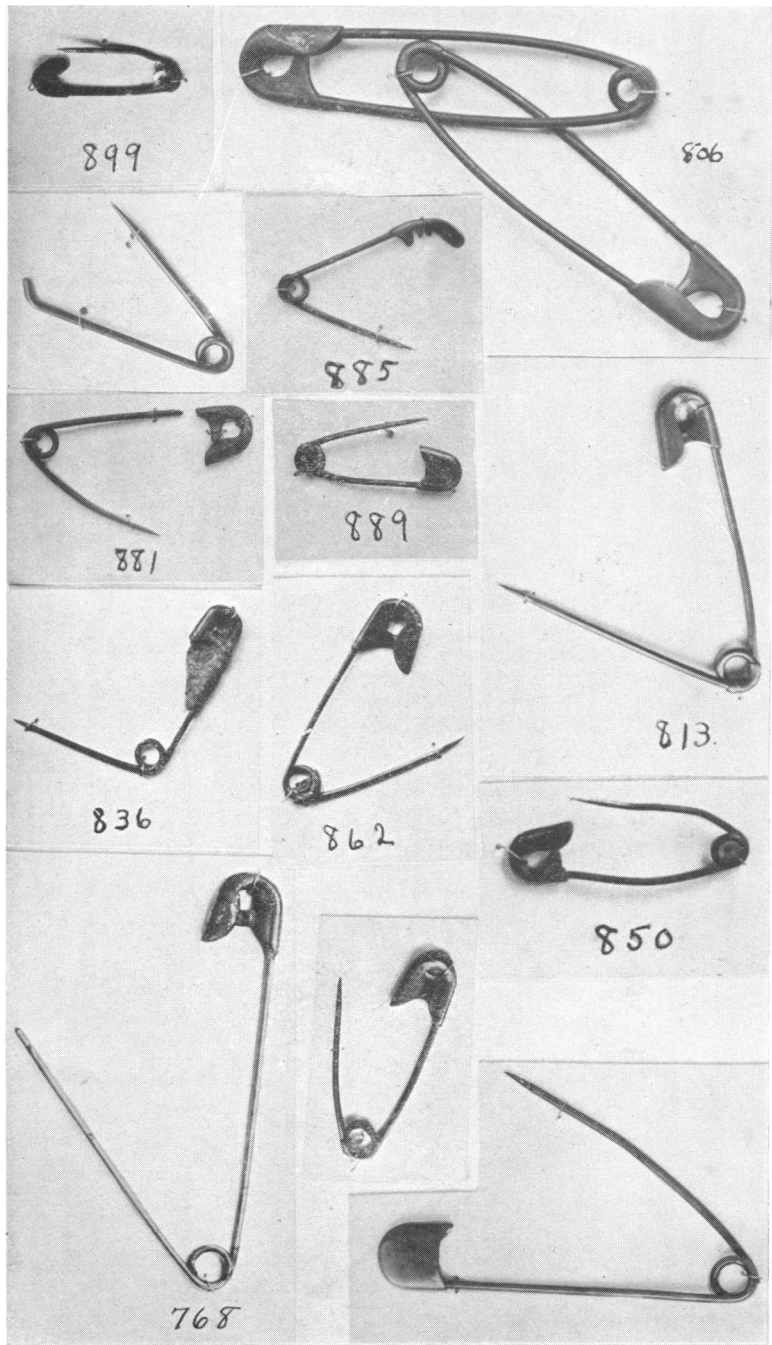


FIG. 39.—Some of the safety-pins removed from the air and food passages, at the Bronchoscopic Clinic by endoscopy through the mouth, without anæsthesia. Some of the open pins were closed before removal, others were removed by the point-protecting method, and still others were removed by endœsophageal or endogastric version.

the foreign body reaches the glottis. The almost inevitable result is the stripping off of the foreign body (Fig. 21).

14. Before inserting forceps, the distance from the tube-mouth to the foreign body should be estimated. The jaws of the forceps going down the tube show in black silhouette against the lighted field. When the jaws reach the light they show up brightly lighted. This localization leaves only the distance from the tube-mouth to the foreign body to be estimated by depth perception.

15. Until the glint of light on the forceps is seen the jaws should never be allowed to open; and in many cases they should not be allowed to open until the intruder is reached. They should, however, open before the intruder is touched and thus displaced.

16. Peanut kernels and similar friable objects must not be grasped so firmly as to crush them. To do this and yet hold the foreign body sufficiently

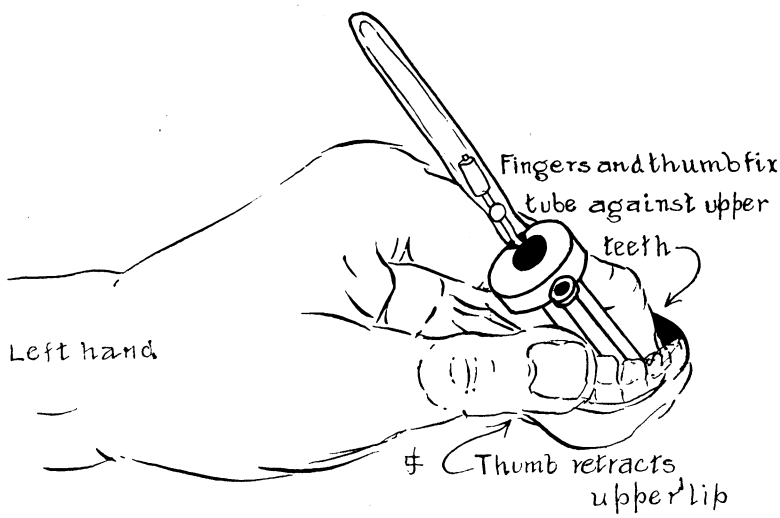


FIG. 34.—Having found the foreign body and developed the proper presentation, by version or otherwise, the tube is fixed against the upper teeth with the thumb and finger of the left hand, as here shown, in order to maintain the presentation until forceps are inserted and the foreign body is properly grasped, according to the mechanical problem presented. Neglect of this precaution is the cause of many failures.

firmly to withdraw it requires the training to be acquired only by the preliminary practice in crushing hundreds of peanut kernels with the bronchoscopic forceps. Allowance must be made for variations in resistance to crushing according to the degree of roasting and to a slight extent the degree of maceration.

17. Because of the limitations imposed by the necessity of working at a distance through a tube with one eye only, training of the eye and the fingers to the peculiar, ocularly guided, bimanual manipulations of forceps and tube are necessary to a large percentage of successes. As with all other manual things the knowledge of how to do them is not enough. Nerve-cell habit

should be established by practice until the manipulations are made subconsciously as with the knife and fork in eating.

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