

## THE USES AND DANGERS OF LIPIODOL IN BRONCHOGRAPHY.

BY J. BURNS AMBERSON, JR., M.D., AND H. McLEOD RIGGINS, M.D.,  
LOOMIS, N. Y.

From the Tuberculosis Service, First (Columbia University, College of  
Physicians and Surgeons) Division of Bellevue Hospital, New York.

(ABSTRACT)

The intelligent use of iodized oil (lipiodol) and other radiopaque oils for diagnostic bronchography has given us a better understanding of a number of pulmonary diseases and often is an invaluable guide to practical treatment. Nevertheless, it has its disadvantages and dangers which have not been sufficiently described. The purpose of this study is to define the scope of the method more clearly and to indicate means of avoiding the dangers.

### DISADVANTAGES AND DANGERS.

*Retention of lipiodol in the lung:* Frequently lipiodol is found by repeated roentgenograms of the chest to remain in the lungs for weeks and in some cases for at least several years. Often the shadow of this retained lipiodol is surrounded by a halo resembling an inflammatory reaction, but which is apparently due to an acellular exudate. Such persisting shadows often are a distinct disadvantage when roentgenograms are studied later for diagnostic purposes. Apparently in most cases the lipiodol and surrounding exudate are soon absorbed or discharged through the bronchi and no damage to the lung results. However, when it is long retained, granulation and fibrosis may result in some cases because of foreign body irritation. Since coughing will propel the lipiodol into the finer bronchial passages and alveoli and favor its retention there, the procedure should be carried out to avoid stimulating coughing. The common practice of urging patients to cough up the lipiodol after the roentgenogram is made is condemned. Instead, the patient should be advised not to cough and is given postural drainage; *i.e.*, placed on a table with

his shoulders lower than his hips so as to allow most of the oil to flow out of the bronchi by gravity.

*Iodism:* We have seen this a number of times and it is reported occasionally to be serious, even fatal. It is due most likely to the action of intestinal juices in liberating iodine from lipiodol which has been coughed up and swallowed. Some suggest testing the patient beforehand by giving him orally 30 gr. of an iodide divided into three doses. Others induce emesis if any lipiodol is swallowed. If the lipiodol is injected carefully, if cough is restrained, and if the lipiodol is eliminated by postural drainage after the bronchography, iodism is not likely to occur.

*Bronchopneumonia:* We have seen three cases of bronchopneumonia, one fatal, caused by the introduction of lipiodol, and other are reported in the literature. To avoid this complication, use of the method should be postponed for at least two or three weeks after evidence of any acute or subacute respiratory infection has cleared away; postural drainage should be employed before introducing lipiodol in cases with much sputum in order to clear the bronchi; and the mouth should be cleaned before the procedure to avoid the possibility of carrying down infection from this source. In hemorrhage cases time should be allowed to elapse after active bleeding before giving lipiodol.

*Spread of lung abscess:* In one of our cases there was an acute spread of a lung abscess following the introduction of lipiodol during the active inflammatory stage of the process. No such misfortune has occurred in a number of chronic healing cases in which the sputum had become scanty before bronchography was attempted. The method, therefore, is to be considered dangerous in acute suppurative disease of the lung. Furthermore, it is usually futile for diagnosis, since the swollen bronchial lining often prevents the entry of the lipiodol into the abscess cavity.

*Spread of tuberculosis:* In one case of febrile exudative pulmonary tuberculosis lipiodol was introduced to determine the possible presence of a bronchostenosis. Some of the lipiodol was retained in healthy parts of the lung, in which new acute tuberculous lesions later developed and proceeded to a fatal issue. Without much doubt the lipiodol carried with it tubercle bacilli contaminating the tracheal

and bronchial surfaces, and these germs were retained with the oily vehicle. In fibroid cases with negative sputum we have not met with such an accident, and the same has been true when lipiodol has been carefully introduced into one lung already widely involved with fibroid and cavernous tuberculosis and secondary bronchiectasis.

*Atelectasis:* Our series includes one case of lower lobe atelectasis following bronchography, and others have been reported. Postural drainage immediately after the procedure should help to avoid this.

*Hemorrhage:* One of our patients died from a sudden inundating pulmonary hemorrhage a month after lipiodol was introduced. X-ray films showed that a great deal of the lipiodol was retained in and about the bronchiectatic area in the right lower lobe as well as in the other lung, and that there was a surrounding exudative reaction. Whether or not the local reaction in some way precipitated the hemorrhage is impossible to say. Forestier had a fatal hemorrhage in a lung abscess case.

*Dyspnea and death from sudden reduction of the vital capacity:* A patient with extensive pulmonary fibrosis and emphysema and suspected bronchiectasis had recovered from symptoms of cardiac failure after a few weeks rest in bed and seemed to be in good condition. Previous to bronchography a house physician ordered codein, gr. 1, sodium amytal, gr.  $1\frac{1}{2}$  and atropine, gr.  $1/50$ . An hour later he was slightly stuporous, but lipiodol was introduced into the bronchi nevertheless. Less than 10 c.c. was injected, but immediately after having a roentgenogram made, the patient collapsed and died. This apparently was due to cardiac failure induced by extraordinary physical exertion, too much medication and the sudden reduction of breathing space which had already been seriously depleted by chronic disease. In two other cases of pulmonary fibrosis described to us severe dyspnea followed the introduction of lipiodol.

S. Singer reports a death in a case with a tumor blocking one main bronchus. The injected lipiodol shut off the other bronchus and the patient died from suffocation. It is obvious that extreme care should be used in case the lungs are seriously damaged or in case one bronchus is blocked. If lipiodol is given at all, it should be in small quantities and only one small section of a lung should be mapped at one time. In extensive bilateral pulmonary fibrosis and

emphysema and in cases with impaired cardiac function lipiodol bronchography had better not be used.

*Disadvantages of the needling method:* In young children some inject the lipiodol through a needle inserted through the cricothyroid membrane, but we prefer to insert it in the midline between one of the upper tracheal rings. A few use this method even in adults. Despite the use of careful technique, lipiodol often leaks into the fascial planes of the neck and may even find its way into the mediastinum, where it remains indefinitely. One of our cases developed cellulitis of the neck, requiring surgical drainage, apparently because infectious material escaped from the trachea through the needle puncture. Fatal air embolism has been reported using the cricothyroid membrane route. Bonnamour cites cases of surgical emphysema, edema of the larynx and fatal infection starting in the tissues of the neck. Technical care and skill go far in avoiding these accidents, and preliminary medication as described below helps by quieting the patient and inhibiting his cough reflex. Nevertheless, the oral route is simpler and not attended by these peculiar hazards.

#### USES OF LIPIODOL.

The sphere of bronchography, of course, depends on the point of view of the individual clinic or physician. In our judgment the method should be used only by those who have a good understanding of respiratory mechanics and adequate experience in the diagnosis and management of pulmonary disease. Otherwise, harm is bound to result sooner or later. Although we see more than three thousand tuberculous cases and more than six hundred chronic nontuberculous or questionable pulmonary cases a year, we perform only 150 to 200 bronchographies. This reflects our view that lipiodol injection is indicated only in cases selected after a careful clinical, X-ray and laboratory study. Safety for the patient undergoing bronchography depends on such selection and on the use of proper technical procedures.

#### SUMMARY OF INDICATIONS AND CONTRAINDICATIONS.

*Bronchiectasis:* Bronchography is usually indicated when all the evidence points to this as a probable cause of respiratory symptoms. When surgical treatment, such as lobectomy, is contemplated pre-

liminary bronchography is necessary to help define the extent of the disease. In a few cases of pulmonary hemorrhage of obscure cause, lipiodol injection will demonstrate the presence of a "dry" bronchiectasis.

The method should not be used if there is a complicating acute or subacute bronchopneumonia. If there is extensive bilateral fibrosis and emphysema (almost always associated with impaired cardiac function) bronchography is of little or no practical value and is dangerous.

*Pulmonary abscess:* After all constitutional and local symptoms, except perhaps for a small amount of mucoid sputum, have disappeared and the X-ray shows almost complete clearing of the lung, lipiodol introduced into the affected area sometimes demonstrates a residual cavity of bronchiectasis which is of importance in prognosis and further treatment.

Bronchography is contraindicated in the acute stage of abscess because it usually adds no practical information and favors dissemination of the infection into other parts of the lung.

*Bronchostenosis due to intrinsic or extrinsic tumors, granulations, foreign bodies, aneurysm, etc.:* Lipiodol bronchography may demonstrate the point of obstruction, especially if this cannot be visualized by bronchoscopy, or if bronchoscopy is definitely contraindicated. As a rule, however, lipiodol injection is superfluous since bronchoscopy suffices to discover not only the location, but also the nature of the obstruction.

In such cases lipiodol is to be used with care, if at all, in order to avoid blocking the only patent bronchi.

*Tuberculosis:* Bronchography is seldom necessary, since an ordinary roentgenogram usually gives adequate information. When a lung is opaque to the X-ray because of pleural thickening and fibrosis or after a thoracoplastic operation lipiodol may occasionally be introduced to delineate the presence and extent of excavation or bronchial distortion and dilatation.

In positive sputum cases the danger of spreading the tuberculosis into healthy sections of the lung, especially if the patient coughs while the lipiodol is in his bronchi, should be given great weight. Because of this the method is not to be employed in exuda-

tive or caseous tuberculosis, or in cases with profuse expectoration, or soon after a hemorrhage.

*Fistulous tracts entering the bronchi or trachea from the pleura, chest wall, spine, etc.:* Bronchopleural fistulas can usually be determined by clinical methods or by injecting dye into the pleural cavity. Occasionally, lipiodol injected into the pleural sac or into some other abscess or fistula may be visualized entering the lung, thus proving an unsuspected communication and its location. We have thus demonstrated a Pott's abscess opening into the neck and into the trachea or bronchi.

*Tracheal deflection or stenosis:* Usually the trachea can be visualized by simple roentgenographic methods, but occasionally it is outlined to great advantage by coating the surface with lipiodol. Distortion and pressure, as by a substernal thyroid, may thus be demonstrated.

*Relative contraindications:* In active *hyperthyroidism* lipiodol should be used with great caution or not at all, since the iodine liberated from the swallowed oil may do harm. Bromipin, a brominized oil, has been advised by some as a substitute. *Drug idiosyncrasy* may lead to severe iodism, but if the patient does not cough, postural drainage will probably avoid this by eliminating most of the oil after bronchography. *Acute respiratory infections* contraindicate use of lipiodol until these have completely cleared away. *Pulmonary fibrosis, advanced emphysema, or cardiac weakness* causing a serious reduction of vital capacity are contraindications.

#### TECHNIQUE.

*Preparation of the patient:* An hour before introducing the lipiodol it is advantageous in most cases to give, by mouth, codein sulph., gr. 1 to  $1\frac{1}{2}$  and sodium amytal, gr. 3. Occasionally, atropine sulphate gr.  $1/100$  to  $1/50$  may also be given. With this preliminary medication the patient is quieter and less likely to cough, and the flow of oral and bronchial secretions is inhibited. To guard against the aspiration of infectious material from the mouth, the patient should brush his teeth with sodium perborate or other suitable powder, and rinse his mouth and throat. Previously, if the amount of sputum is considerable, the patient should drain his bronchi by hanging over the edge of a bed or table, head and shoulders down, for ten

to twenty minutes. This clears the passages for better lipiodol filling and helps prevent coughing and overflow of infectious secretions into healthy sections of the lungs during such filling. Occasionally it is unnecessary to anesthetize the throat, but we find it more satisfactory as a rule to do so. The pharynx and anterior faucial pillars are sprayed with a 4 per cent aqueous solution of cocaine, and if the upper third of a lung is to be injected, the larynx also is so anesthetized.

*Temperature of the lipiodol:* Heating the lipiodol above body temperature lowers its viscosity and makes the injection easier for the operator, but there are objections. As we have learned, a very freely flowing oil enters the pulmonary alveoli more readily, thus tending to obscure the roentgenographic distinctness of the bronchi. Furthermore, oil in the alveoli is not easily expelled and may remain trapped there indefinitely, a disadvantage discussed above. It is better, therefore, to warm the oil to a temperature of only 70 to 80 degrees.

*Section to be injected:* As a rule it is advisable to inject only one lobe or section of the lung at a sitting, since this helps to avoid accidents. For a lower lobe 15 to 20 c.c. of lipiodol suffice, and for the upper third of a lung, 10 to 15 c.c.

*Injection by oral or supraglottic route. Lower parts of the lung:* The patient sits on a chair, leaning one way or another, according to the lobe to be injected. For the right lower lobe he leans backward and to the right; for the right middle, forward and to the right; and so on. Holding the patient's tongue, the operator slowly injects the oil with a syringe attached to a curved laryngeal cannula, the tip of which is held above or just behind the epiglottis. Meanwhile, the patient is advised to breathe naturally.

*Upper parts of the lung:* The patient lies on a table on his affected side. The shoulder is lowered so that the apex of the lung is dependent, and with the lowermost forearm flexed the patient props his head in his hand. With the patient's neck bent toward the unaffected side, the operator, with the aid of a laryngeal mirror, places the tip of the cannula in the larynx and injects the oil quite slowly. This done, the patient turns on his back with his shoulders dependent

so that the oil does not flow into the lower bronchi, and the roentgenogram is made.

*Fluoroscopy and roentgenography:* It is usually advisable to fluoroscope immediately to ascertain roughly the extent of the filling. Roentgenograms are then made, employing a very long exposure in order to produce maximum visualization of the contrast material. Since a long time exposure may lead to blurring from motion, the X-ray tube may be moved close (24 inches target-film distance) thus increasing the penetration. Lateral views are also made to localize the injected parts more accurately; sometimes oblique views too. Stereograms may be made, but we find posteroanterior, lateral and oblique views more serviceable.

*Emptying the bronchi of lipiodol:* During the foregoing maneuvers it is important for the patient to restrain coughing. After the roentgenograms are made the patient hangs over a table to drain his bronchi, *without coughing*. Most of the oil will flow out in ten or fifteen minutes.

*Transtracheal route:* In young children and occasionally in older people the oral route is impractical or intolerable, and the lipiodol may be injected by means of an 18-gauge needle inserted in the midline of the neck, between two of the upper tracheal cartilages. The patient is prepared as described above and is placed on his back on a table, a rolled pillow beneath his neck and his head extended over this. Care should be taken to prevent the escape of lipiodol into the cervical tissues. This is facilitated by entering the trachea with a needle and syringe containing novocaine anesthetizing solution; then, with the needle in place, changing the syringe for one containing the oil. This method is not favored, except as a necessary substitute.

*Bronchoscopic route:* This is recommended by some because one can inject the lipiodol into a chosen single bronchus. However, we have not found it satisfactory because the lipiodol usually flows to other parts as the bronchoscope is withdrawn or is blasted about the bronchial tree by the heaving and coughing that almost inevitably attend and follow bronchoscopy. Furthermore, when lipiodol is injected into a single bronchus through a long cannula it seems easy to rupture the pulmonary tissues and force the oil into the interstitium. Here, it accumulates in a pool, which is easily mistaken in

the roentgenogram for a bronchial sacculation, and remains indefinitely encysted, perhaps to the detriment of the patient. We have seen three cases in which this occurred.

*Injection of fistulas and abscess spaces:* This is a simple procedure and may be done with a needle or small catheter. It is well to wash out the contained discharge before injecting the lipiodol. Until the roentgenogram is made the lipiodol should be sealed, if necessary, in open external fistulas.

#### DISCUSSION.

DR. JAMES A. MILLER: I have very little to add to Dr. Amberson's presentation. I think it is obvious in a series such as we are fortunate to have at Bellevue that the uses of this method are very numerous, and it is very helpful. I think that one who sees it cannot help but be impressed with the importance of very careful, patient technique. It takes a lot of time often to get your lipiodol where you want it, and it is only by careful patience, such as Dr. Riggins and Dr. Amberson have developed, that results can be gotten satisfactorily. That it is a diagnostic procedure of very great value is known to all of us, but I think perhaps it is not so well recognized that there are certain definite disadvantages, and that cases for which this method should be used should be selected carefully; also that certain procedures to obviate such disadvantages should be resorted to.

The first thing that I think we should all think of is the question of the possibility of doing harm, and that can happen in some cases, particularly in tuberculosis, as Dr. Amberson has pointed out. The only exception that I can think of in which we have used it in tuberculosis very cautiously and with help particularly, is in the case of post-operative thoracoplasty where there is a question as to whether or not a small residual cavity is left which might lead the way toward further need of surgical procedure. In such cases very small quantities of lipiodol, immediately drained out in the way Dr. Amberson has suggested, have been given.

The second thing, this question of iodism is, perhaps, more important in certain types of cases than in the series that Dr. Amberson reported on. We have seen in private practice a considerably higher percentage of iodism, and it is anything but a pleasant experience. That leads to the question to find out whether or not the patient is sensitive to iodine. Iodine is very often used by many intelligent people, and if you question your patient you will often find out that he is sensitive just to the local application of iodine. One should be very careful about this, but even in cases where you suspect this sensitivity you can give them a small dose of iodine by the stomach in some form of iodide and see whether they are sensitive or not; but if they are, the question of draining it out carefully, as has been indicated, will obviate that very unpleasant and occasionally reported fatal complication.

The thing particularly I would like to emphasize is the question of its use in acute, very extensive pulmonary abscess. In these conditions we have seen that it can do very real harm, as Dr. Amberson has said, so we no longer use it. Moreover, in an acute or subacute pulmonary abscess the amount of information you get from it is practically nil for the reason that the iodine does not penetrate into the part of the lung which you wish to visualize, because of the swelling, edema or granulation in the bronchi; it simply fails to enter and you get a negative result, and in going by the oil, which is more fluid than the pus, carries with it some of the infection to new areas of the lung. We have seen cases where it has done real damage.

The bronchogram is a procedure of the greatest value, one we can use always with great help in properly selected cases and with proper precautions. (Applause.)

DR. EDGAR MAYER: Discussing this from the therapeutic point of view, Professor Salant of the Physics Department of the New York University and I have been irradiating oils, including lipiodol, hoping to produce phosphorescence or some form of emission of photo active energy of sufficient intensity to set up a therapeutic effect—if not bactericidal at least sufficient to produce some changes in the cell, which will give a cellular inflammatory reaction favorable for the host and destructive for the organisms.

The bactericidal region has been defined in scientific experiments to be that below about 3150 A.U. That around 2500 A.U. has been shown to have a selective affinity for the lipid component of the cell, and that around 2650 A.U. for the proteid factor. Hemolysis of the red blood cell can be easily produced by the region around 2500 A.U., probably due to an effect on the lipoidal membrane. Destruction of a paramecium with the region around 2650 A.U. is one of vacuolar degeneration due to direct action upon protein by penetration into the cell protoplasm, in contrast to death of the paramecium through destruction of the lipid membrane by the shorter rays around 2500 A.U.

How much these factors will mean in therapeutics must yet be determined.