A Water-Soluble Contrast Medium for Bronchography
Report on Clinical Use†
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The ideal material for bronchography should be:

(1) non-irritating to the lungs and productive of no general reaction,
(2) miscible with bronchial secretions,
(3) quickly and easily eliminated from the lungs,
(4) capable of filling or outlining even the smaller bronchi without filling the alveoli,
(5) capable of maintaining the filling until x-ray films can be exposed,
(6) capable of giving good contrast roentgenogram,
(7) easy to administer,
(8) capable of giving consistently diagnostic x-ray films.

Unfortunately, no material has been found which fulfills all of these requirements. Any substance which enters the lungs must act as a foreign body. For example, even normal saline probably produces a mild reaction in the lungs.1

Iodized oils have for many years been unchallenged as a medium for the x-ray diagnosis of diseases of the bronchi. These oils have certain inherent properties which offer serious objections, the chief of these being their slow resorption with the consequent addition of retained radiopaque densities to confuse the x-ray picture for long periods.2,3 This is due to the fact that oils are insoluble in bronchial secretions and that the iodine is slowly liberated from the oil. In addition to this slow resorption, iodized oils offer further objections: radiopacity is fixed by the constant iodine content, viscosity is fixed by the chemical nature of the oil, oil causes a marked macrophagic reaction of long duration,2,3 lipid pneumonia and granuloma have been reported4 and since iodine is slowly liberated from the oil,5 iodism occasionally occurs.

In 1948, Morales and Heiwinkel6 reported on the use of a water-

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soluble contrast medium, Viscous Umbradil. This mixture consists essentially of Iodopyracet* (diethanolamine salt of 3,5-diodo-4-pyridone-N-acetic acid) and sodium carboxymethylcellulose (CMC). Morales and Fischer have subsequently demonstrated its usefulness.

In addition to being water-soluble, the viscosity can be varied within wide limits and yet the surface tension is low enough to allow the material to reach the smallest bronchi. By varying the viscosity, any degree of filling can be obtained. The low viscosity medium produces a thin covering of the mucosa while the higher viscosity material fills only the large bronchi. The medium of extremely low viscosity, however, frequently causes marked alveolar filling with obliteration of detail in the bronchi. All traces of this radiopaque material disappear from the lungs by X-ray in three to five hours since the material is easily coughed up and the Iodopyracet is quickly absorbed.

**Fate in the Body**

The fate of the constituents of this medium in the body has been studied by various workers. Umbradil (brand of iodopyracet) and other similar organic iodide compounds are rapidly absorbed and excreted by the kidneys. This is well established by the use of these compounds in arteriography and urography.

The fate of the CMC is more complicated. Being water-soluble, much of this material is eliminated by the normal cleansing mechanism of the lung and by postural drainage. Brown and Houghton, and Werle gave CMC to animals and man by mouth and were unable to demonstrate any evidence of absorption or deleterious effects. Shelanski extended these studies and used CMC as a vehicle for medications. Thus, this material is now used as a thickener for ice cream, as a vehicle for medication, and as an antacid in the treatment of peptic ulcer.

Hueper, using dogs, gave CMC intravenously each day for a period of three months. Small amounts were found in the reticuloendothelial system of the liver and spleen, in the endothelium of the renal glomeruli, and in the renal tubules. It was found to much less degree than acacia or other gum preparations. They concluded from their investigation that CMC was probably excreted by the kidney and was not harmful.

Hellstrom and Holmgren injected large amounts of Viscous Umbradil, Umbradil, CMC, and saline into the lungs of rats and rabbits. They noted a transient thickening of the alveolar septum most marked with Umbradil, less so with Viscous Umbradil and

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*Iodopyracet is marketed in this country as Diodrast (Winthrop-Stearns).*
CMC\textsuperscript{R} in that order. There was a macrophagic response with all materials including saline. In the case of Viscous Umbradil this reaction, which is quite similar to that seen with iodized oil, had completely subsided within three weeks. Further, the trachea showed no changes.

To be certain of our own supply of CMC\textsuperscript{R} one cc. of a 2 per cent solution was injected into the peritoneal cavity of small white mice on five consecutive days. None of the animals died. All were sacrificed on the sixth day and no gross abnormalities could be found. Microscopically, small amorphous deposits could be seen on the peritoneal surfaces, but there was practically no cellular response.

**The Medium**

Viscous Umbradil B,\textsuperscript{**} as supplied, consists of Umbradil 50 per cent, sodium carboyxymethylcellulose (CMC\textsuperscript{R}) 2.6 per cent, and a local anesthetic, Xylocaine (diethylaminoaceto-2,6-xylidide), 0.5 per cent. With this material we had difficulty in preventing alveolar filling. The content of CMC\textsuperscript{R} was therefore increased to 3.3 per cent, using high viscosity, food grade type CMC.\textsuperscript{R} In our hands this has given consistently better results and has markedly decreased the amount of alveolar filling, thus keeping the material from the area where the main reaction occurs in the lungs.\textsuperscript{1} The viscosity can, however, be varied to suit the needs of the user.

**Technique of Injection**

The patients are prepared by giving nembutal 0.1 gm. one hour, and codeine 60 mgm., atropine 0.4 mgm. one half hour before the procedure. Pontocaine\textsuperscript{R} 1 per cent is used to anesthetize the larynx, pharynx, and vocal cords. A small rubber catheter is then introduced through the nose and into the upper trachea. The trachea and bronchi are then anesthetized by instilling Pontocaine\textsuperscript{R} 1 per cent through the catheter and positioning the patient to insure thorough, wide-spread anesthesia. This is essential. Five to 10 minutes should be allowed for the anesthesia to take full effect since Viscous Umbradil is a little more likely to produce coughing than are oils. A total of about 6 cc. of 1 per cent Pontocaine\textsuperscript{R} has been adequate and has produced no reactions. Symptoms of Pontocaine reaction should be watched for, however, and intravenous barbiturate should always be immediately available.

The Viscous Umbradil mixture is then injected slowly through the catheter and the patient is positioned to secure filling of the

\textsuperscript{*}The CMC\textsuperscript{R} for this investigation was supplied through the courtesy of Hercules Powder Co., Wilmington, Delaware.

\textsuperscript{**}The Viscous Umbradil B was supplied through the courtesy of Astra Pharmaceutical Products, Inc., Worcester, Massachusetts.
bronchi of one lung. This may be followed fluoroscopically. Speed and efficiency after injection and filling is important since there is a tendency for the material in the upper lobe to flow into the lower. Upright stereoscopic posterior–anterior and appropriate oblique x-ray films are then made. The opposite lung may then be examined in a like manner. About 10 to 15 cc. of Viscous Umbradil are needed for each lung. The fact that the Viscous Umbradil contains 0.5 per cent of a local anesthetic must be taken into account in considering the total anesthetic used.

**X-ray Technique**

The technique of taking films varies slightly from that used with iodized oil. Viscous Umbradil has slightly less contrast than does iodine but this is easily compensated for by the x-ray technique. Morales recommends exposure as for "normal chest x-rays." Our films have been made at a tube-to-film distance of 66 inches and about 5 KV has been added to the exposures for normal chest films in the various positions. With this technique the contrast is entirely satisfactory. Stereoscopic viewing adds to the diagnostic value of the films.

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**Figure 1a, Case 1:** Abscess of right upper lobe. Bronchogram showing large defect in upper lobe (arrows) and upward displacement of right middle lobe bronchus.—**Figure 1b, Case 1:** Roentgenogram taken five hours after bronchography without postural drainage. Artifact over shoulder.
Figure 2a, Case 2: Bronchogram. The posterior basic segment is obstructed (arrow).

Figure 2b, Case 2: Roentgenogram five hours following bronchography.

Figure 3a, Case 3: Complete collapse of right upper lobe (arrows). There is rotation and displacement of the right middle lobe bronchus.

Figure 3b, Case 3: Roentgenogram five hours following bronchography.
Discussion

The various bronchograms presented in this paper were made with the material and technique as presented. Postural drainage following bronchography was purposely omitted. The subsequent x-ray films were made about five hours after completion of the procedure. Some of our earlier films which were made using a less viscous medium showed rather marked alveolar filling. Even in these instances, x-ray films made five hours later were entirely clear. It is obvious that there is no residual to confuse the x-ray picture later. Furthermore, the procedure with Viscous Umbradil can be repeated the next day if too much alveolar filling is apparent on the first attempt at bronchography. This "second attempt" is often impossible with iodized oils because of retained radiopaque material.

Three of our patients had transient, mild elevation of temperature 12 to 24 hours following bronchography. One of these had been bronchosoped immediately prior and had had a similar elevation following routine bronchoscopy 10 days before. The second patient was having rather marked pleuritic pain at the time of bronchography but no other evidence of acute infection was noted. In the third instance, bronchlectasis was apparently quiescent. On subsequent roentgenograms there was no evidence of any change in the pre-existing pathology. In our experience, temperature elevation is also seen not infrequently following the injection of iodized oils.

To date we have seen no reaction to iodine. Because of the stability and rapidity of excretion of Umbradil, further experience may show that this material can be used even where a history of iodine sensitivity exists.

The contraindications to the use of Viscous Umbradil are: (1) the presence of acute respiratory infection, (2) sensitivity to Umbradil (rare), and (3) acute nephritis or uremia since Umbradil is excreted by the kidney.

Viscous Umbradil contains 0.5 per cent of xylocaine, a local anesthetic. In our technique we have been well aware of the fact that two anesthetic agents have been used. This should probably be eliminated.

CONCLUSION

In our experience Viscous Umbradil, a viscous, water-soluble, radiopaque medium, has many advantages over iodized oil in bronchography. We feel that the advantages far out-weigh the disadvantages. Bronchograms with this medium are diagnostic and there is complete absorption of the radiopaque material in three
to five hours without any clinically demonstrable deleterious effect on the lungs. Certainly Viscous Umbradil deserves extensive trial and further evaluation.

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**CONCLUSION**

En nuestra experiencia el *Umbradil Viscoso*, un medio viscoso, soluble en agua y radio opaco, tiene muchas ventajas sobre el aceite yodado en la broncografía. Opinamos que sus ventajas más que sobrepasan sus desventajas. Los broncogramas obtenidos con este medio son diagnósticos y se absorbe completamente la substancia radio opaca en tres o cinco horas, sin ningún efecto nocivo al pulmón. El *Umbradil Viscoso* merece un ensayo general para que se determine su valor en la broncografía.

**REFERENCES**