

## EXPERIENCES WITH SOLUBLE CONTRAST MEDIA IN THE RADIOLOGY OF THE ALIMENTARY TRACT\*

J. I. LEVY, B.A., M.B., B.Ch. (RAND), D.M.R.D. (ENG.), *Diagnostic X-Ray Department, Baragwanath Hospital and University of the Witwatersrand, Johannesburg†*

During the past 50 years barium sulphate has been used consistently as the contrast medium for the radiological examination of the gastro-intestinal tract. Today highly purified preparations of this medium of very fine particle size are available, which are extremely satisfactory for routine diagnostic purposes and will certainly continue as the medium of choice for routine practice. It is felt, however, that there are three classes of patients in which the use of barium is contraindicated.

1. The first group is that in which there is a possibility that the contrast medium may be deposited outside the alimentary tract. The objection to barium in these instances is that it is insoluble and irritant, it initiates a foreign-body reaction, and it may leave permanent X-ray opacities. Barium may enter the bronchial tree in two ways: firstly if there is oesophageal obstruction or in-coordination of swallowing it may spill over the larynx and may be aspirated down the trachea; secondly it may enter the bronchial tree directly through a fistula of congenital, traumatic, inflammatory or malignant type. Barium may enter the lung directly if there is an erosive invading carcinoma of the oesophagus present. It may enter the mediastinum if there has been trauma to the oesophagus, for example by instrumentation or *via* a fistula. It may enter the pleura in cases of trauma or *via* a leaking surgical anastomosis. It may enter the peritoneum after rupture of a hollow viscus, after traumatic perforation, or from a leaking suture line.

2. The second group comprises the *intestinal obstructions*. Here the objection to barium is that by its weight and volume it may rupture the already distended and thinned viscus on the proximal side of an obstruction. There is also the possibility that it may convert a partial obstruction into a complete one, particularly in the colon, where the water in which the barium is suspended is absorbed by the colonic mucosa and a hard inspissated mass remains. If early surgical intervention is necessary after barium has been administered, its presence in the bowel may be a nuisance to the surgeon, and if the barium contaminates the peritoneum during operation there is the possibility of granuloma formation. It may also retard the postoperative healing of any anastomosis that may be performed.

3. A third category is the *young infant* (under 3 months

of age, possibly even up to a year old). In giving barium to the newborn there is always the danger of imperfect swallowing and aspiration into the bronchial tree, with resultant pneumonia. Also there are many paediatricians, notably at Baragwanath Hospital, who abhor the use of barium, no matter how thinly suspended, on the grounds that the narrow channels of even the normal infantile alimentary tract are too easily occluded by the thick inspissated clumps which are thought to result from ingested barium. A death attributed at autopsy to barium inspissation and impaction is recorded in a debilitated infant following a barium enema at Baragwanath Hospital.

We have therefore made a trial of the two recently introduced aqueous iodide compounds, 'oral hypaque' and 'gastrografen', in 135 selected examinations where it was felt that the use of barium was contraindicated (Table I). It is not considered that these compounds could or should

TABLE I. 135 ALIMENTARY TRACT EXAMINATIONS USING SOLUBLE CONTRAST MEDIA

Type of examination and reason for examination	No.	Total
<i>Swallow</i>		
Infant (? atresia, varices, stricture or perforation of oesophagus) ....	9	
Dysphagia (? carcinoma of oesophagus with fistula or total obstruction) ....	33	
Postoperative examination of oesophagus ....	17	59
<i>Meal and follow-through</i>		
Infant (? pyloric or duodenal obstruction) ....	12	
? Intestinal obstruction (adults) ....	16	
To obtain a rapid follow-through (e.g. ? gut in abnormal position)	14	
? Intestinal fistula ....	8	
Postoperative suture leak or obstructed anastomosis ....	7	57
<i>Enema</i>		
? Hirschsprung's disease (infants)	14	
? Colonic fistula ....	5	19
Total		135

replace barium for ordinary routine examinations. Oral hypaque was used in 114 examinations and gastrografen in 21. Soluble media were not used in this series to demonstrate a bleeding point in cases of acute haemorrhage in the alimentary tract.

### Advantages of Soluble Contrast Media

1. The soluble media are chemically similar to their urographic counterparts but they have been modified specifically for oral or rectal administration. Unlike barium, which is a suspension of insoluble particles, they

\* Based on a paper read at the Central African Radiological Congress, Bulawayo, May 1962.

† Present address: Department of Radiology, Johannesburg General Hospital.

are completely soluble and form true solutions. There is therefore no danger of impaction anywhere in the bowel. They can be freely used in infants.

2. One of the outstanding features of these media is their accelerated rate of passage through the bowel as compared with barium (Fig. 1—A and B). Frequently the entire small gut is opacified within 20-30 minutes of the start of the examination and the colon may often be demonstrable after a further  $\frac{1}{2}$ -1 hour (Figs. 1B, 2A and 3). Thus the whole of the gastro-intestinal tract from stomach to rectum may often be visualized in continuity in 60-90 minutes. The advantages of this rapid transit whereby a follow-through examination can be completed at one session are as follows: there is less inconvenience to the patient and radiologist, a diagnosis can be established in a much shorter time, there is less delay if surgical intervention is necessary, fewer films are required, and there is less radiation of the patient. With barium the patient may have to return for films at intervals up to 48 hours in order to obtain a complete follow-through to the rectum.

3. Another advantage is that these opaque media are rapidly eliminated from the bowel. Invariably, if further radiological studies are required on the day following a hypaque or gastrografen meal, the abdomen is found to be clear of contrast medium and the annoying problem of residual shadows that is so frequently present after barium does not arise (Fig. 2B).

4. The media are freely absorbed from serous surfaces such as the pleura and peritoneum and from mucous surfaces as in the bronchial tree. There is no danger of foreign-body reaction, and residual opacities do not present a problem.

5. The outstanding attribute of the soluble media is that they can be used in intestinal obstruction. This represents a real advance in modern radiological technique (see below).

6. The soluble media are of much lower viscosity than barium and are readily able to negotiate narrow channels such as fistulae. Investigation for the presence of intestinal fistulae is therefore another indication for their use.

#### *Disadvantages of Soluble Contrast Media*

The soluble iodides are not ideal contrast media and they have several disadvantages.

1. They are unpleasant to take because of their bitter taste. Gastrografen is flavoured by the manufacturers with a liquorice flavouring. Oral hypaque can be flavoured as desired by the user. However, we have mixed the latter with plain tap-water and no patient has rejected it on account of taste.

2. Some patients experience a transient diarrhoea after the administration of the soluble media. The reason for this is that in the small bowel the hypertonicity of the iodide solution causes a diffusion of fluid into the lumen of the gut. The diarrhoea disappears as soon as the medium is evacuated, and in fact assists rapid elimination.

3. Also because the diffusion of fluid into the lumen produces dilution and diminished density of the medium, these substances are incapable of demonstrating the mucosal pattern of the small gut (Fig. 1B).

4. The soluble media are valueless in the examination of the normal adult oesophagus. They pass too rapidly down the unobstructed gullet and, unlike barium, they have no power of adhesion to the oesophageal mucosa. If the descent of a hypaque bolus is followed visually on the screen down a normal oesophagus and a radiograph is exposed immediately thereafter one finds there is little or no residual contrast medium present to be recorded on the film. However, adequate pictures of the filled oesophagus were always obtained in infants, probably because of the almost continuous swallowing of the medium during sucking from a bottle feed and the slower rate of passage due to the invariable supine position (Fig. 13B).

5. The soluble iodides are much more expensive than barium.

6. Finally there is the question of possible toxicity (see below).

#### EXAMINATION OF THE OESOPHAGUS

The preponderance of oesophageal examinations in this series reflects the high incidence of oesophageal carcinoma in the African population served by this hospital. 65 new cases of cancer of the gullet were admitted to Baragwanath Hospital during the year 1960 and 89 new cases during 1961.<sup>1</sup> Our experience is that a large proportion of sufferers from this deadly malady seek medical advice for the first time with advanced disease. Total obstruction of the oesophagus is commonly seen (e.g. Figs. 4 and 5) and malignant oesophago-tracheal, bronchial or pulmonary fistula is found to be present in about 20% of cases at the first radiological examination (Fig. 6). These cases thus present a special radiographic problem, for when either of these conditions is present contrast medium may enter the bronchial tree, directly *via* fistula, or by laryngeal overspill and aspiration down the trachea if there is total occlusion of the lumen of the gullet, particularly with high tumours, which often give rise to inco-ordination of the swallowing mechanism.

The prognosis in cases with fistula is hopeless and the most that can be done is an attempt to block the fistula by some form of intubation. But patients with total or almost total obstruction of the oesophagus who aspirate their swallow into the bronchial tree fall into a different category. Many of them are considered by our surgeons to be operable, albeit heroic and hazardous surgery is required to alleviate their distressing condition, frequently as an emergency measure on the day following radiological examination. Then their ability to withstand the prolonged anaesthesia and the postoperative course must be seriously impaired if the radiologist has allowed barium to flood the bronchial tree. We therefore feel that, for the primary radiological diagnosis of the cause of dysphagia in an adult African patient whose clinical state is suggestive of malignancy, the examination should commence with a swallow of an aqueous iodide medium. If carcinoma of the gullet is seen not to be present or if a carcinoma is present but there is no evidence of fistula, and if obstruction is not excessive, the examination may then be continued with a suspension of barium sulphate.

In the past it has been customary to use iodized oils

for the study of the gullet when the use of barium has been felt to be undesirable. These oils are unsatisfactory because they globulate on contact with the watery oesophageal mucosa and they therefore fail to delineate the contours and to coat the mucosa of the viscus adequately. The appearances which result can often be quite misleading (Fig. 7—A and B).

Soluble media are valuable for examining the oesophagus after operation. The use of barium is precluded after oesophagectomy and oesophago-jejunal or oesophago-gastric anastomosis because of the possibility of leakage from the suture line into the mediastinum or pleura. The ability of the iodide solution to mix intimately with secretions and so evenly coat mucosal or serous surfaces, and its capacity to run freely through narrow channels, make its use preferable to iodized oils.

Figs. 8 (A and B), 9 and 10 demonstrate hypaque swallows after radical procedures on the oesophagus. After palliative intubating operations on gullet cancers radiological examination may be required to make sure that the tube has been placed at the correct level and that it is patent. Oral hypaque or gastrografen is again preferable to barium for this, because complete obstruction (Fig. 11) or fistula may still be present.

Leakage of oral hypaque into the pleura was seen in 8 oesophageal examinations (Figs. 8 and 9), in some of these the amount reaching the pleural surface being considerable (Fig. 12B). This finding raised some concern about the advisability of using a non-sterile medium in such circumstances. Several surgeons who were consulted felt it was unlikely that any extraneous pathogen would be introduced so long as ordinary hygienic principles were observed in preparing and administering the contrast medium. Moreover in the presence of an oesophago-pleural or gastro-pleural fistula the pleura is already contaminated and, further, a sterile contrast medium given orally is surely no longer sterile once it has passed the mouth and pharynx.

An oesophageal examination in a neonate by means of oral hypaque is illustrated in Fig. 13 (A and B).

#### EXAMINATION OF STOMACH, SMALL BOWEL AND LARGE BOWEL

In the stomach soluble media coat the mucosa in a way comparable to barium and their demonstration of the pattern of rugal folds is satisfactory for diagnostic purposes (Fig. 1A). Their behaviour in the gut, however, differs considerably from that of barium and the radiological appearances are also different. In the small bowel the high osmolarity of the iodide solution causes a diffusion of fluid into the lumen, which produces rapid dilution and diminished density of the medium and a loss of the mucosal pattern appearance of the jejunum and ileum (Fig. 1B).

Although detail of structure, contour and mucosal pattern of the small bowel is lost with aqueous iodide solutions, their use is valuable when one wishes to learn rapidly *where* the bowel is. Information about gross anatomical situation or abnormal displacement is easily and

quickly obtainable. For example the problem of traumatic diaphragmatic hernia is regularly encountered at this hospital, where stab wounds of the chest are seen in large numbers. A patient with a history of a penetrating thoracic injury may be found on X-ray of the chest to have a suggestive basal translucent shadow which poses the question whether there is bowel above the diaphragm. The answer is rapidly obtainable by an oral hypaque or gastrografen follow-through examination, which will exclude or confirm a diaphragmatic hernia and if present will demonstrate whether stomach, small or large bowel is in the chest (Figs. 12—A and B). Similarly the technique

*Fig. 1.* Oral hypaque meal and follow-through for suspected intestinal obstruction. A: Supine film immediately after ingestion of contrast medium, showing good demonstration of gastric mucosal folds. B: After 1 hour. Note rapid transit—the medium is distributed throughout small bowel and most of large bowel. No hold-up or distension to suggest obstruction. Dilution in small gut lowers the density and obliterates mucosal detail. Note the precipitate of high-density particles in stomach, duodenum and proximal jejunum.

*Fig. 2.* Partial duodenal obstruction. 8-day-old infant vomiting persistently. Oral hypaque meal and follow-through. A: Supine film at 2 hours. The stomach and duodenum are dilated. Reflux occurs up the oesophagus. Contrast medium has traversed the entire alimentary tract and is already in the rectum. The time for total gastric emptying, however, was prolonged. B: Supine film at 24 hours. Only a trace of oral hypaque is seen in the rectum. Note the residual granular precipitate of almost metallic density in the stomach. At operation obstructing bands in the region of the paraduodenal fossae were freed.

*Fig. 3.* Erect film of abdomen 90 minutes after drinking 200 ml. of 30% oral hypaque to exclude intestinal obstruction. The medium is in terminal ileum and colon and has reached the rectum. Fluid levels in colon, but no obstruction present. Final diagnosis: ileus due to peritonitis.

*Fig. 4.* Male African aged 58. Admitted for dysphagia, gross dehydration and vomiting. Lateral view after swallow of 30% oral hypaque. Carcinoma mid-oesophagus. Total obstruction.

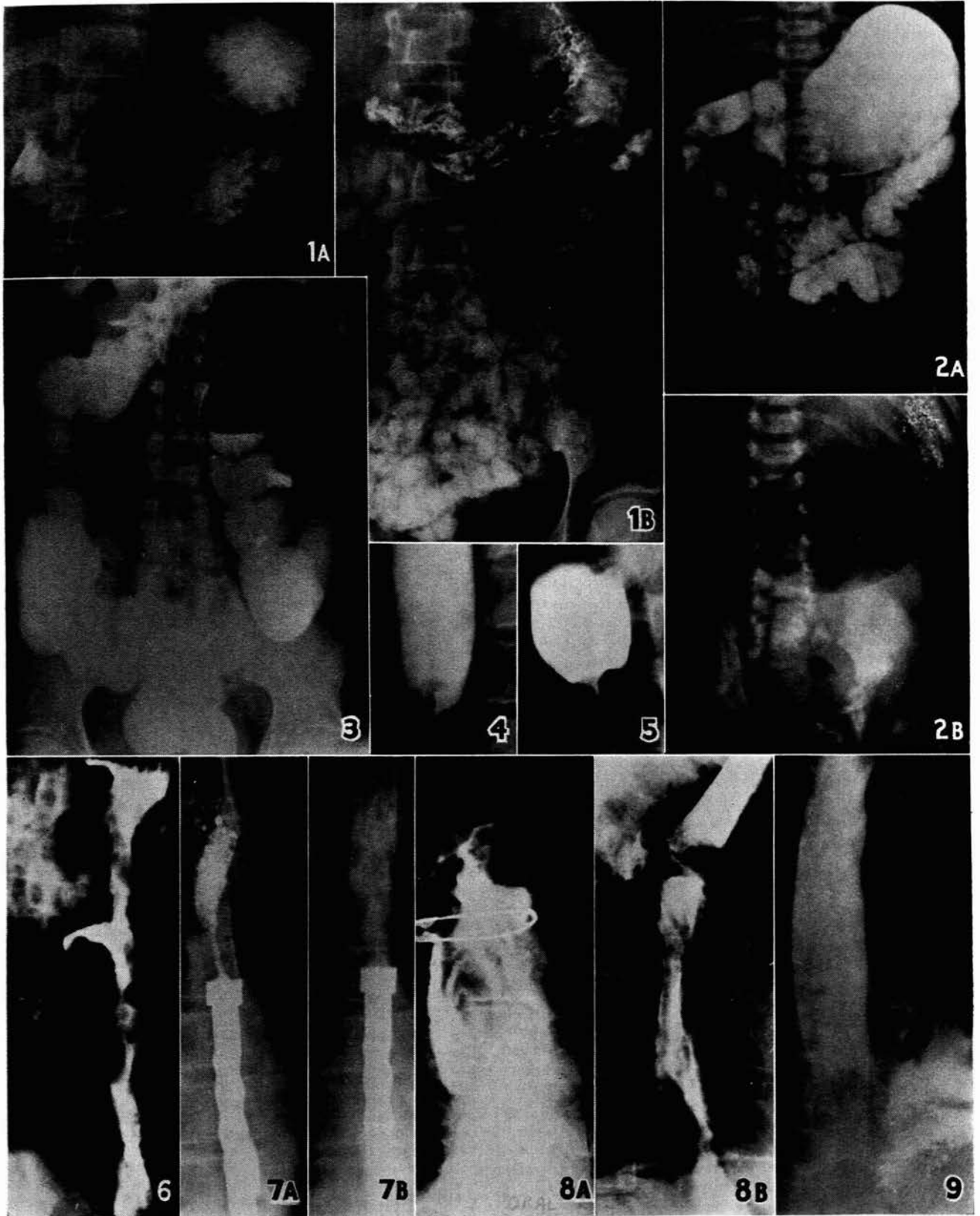
*Fig. 5.* Male aged 54. Oblique view after swallow of 60% oral hypaque. Carcinoma almost totally obstructing mid-oesophagus.

*Fig. 6.* Oral hypaque swallow. Large carcinoma of oesophagus with direct fistulous invasion of apex of right lower lobe. Plain films showed an abscess cavity with fluid level in this segment.

*Fig. 7.* Comparison between swallows of iodized oil and aqueous medium. Carcinoma of oesophagus with Souttar's tube *in situ*. A: iodized-oil swallow. Note poor mucosal coating, globulation, and false impression of a stricture above the tube. B: Same patient after oral hypaque swallow. The medium is evenly dispersed on the mucosa and shows the true contour of the viscus.

*Fig. 8.* After oesophagectomy and oesophago-gastric anastomosis for carcinoma of oesophagus. Postero-anterior (A) and lateral (B) views after oral hypaque swallow. A leak runs postero-laterally into the pleura from the suture line.

*Fig. 9.* After palliative oesophago-jejunal anastomosis to bypass an inoperable obstructing carcinoma of the stomach. Swallow of 50 ml. of 40% oral hypaque demonstrates minimal filling of jejunum and a large leak from the suture line into the pleura. The contrast medium emerged at the incisional wound and soaked the skin dressings.



can be used for umbilical, inguinal and other herniae, particularly if a degree of obstruction is suspected.

The value of the aqueous iodide media in intestinal obstruction has been well documented,<sup>2,3</sup> and is further substantiated in this series. Although plain films of the abdomen in suspected cases of intestinal obstruction are generally of the greatest usefulness and may be conclusive, yet not uncommonly the diagnosis of the anatomical situation of the obstruction is equivocal. In these cases soluble media are of assistance in identifying the site of a mechanical block (Figs. 2A, 14 and 15), and, unlike barium, can be given without fear that the medium may impact in or cause perforation of distended viscera. Because of the rapid transit of the aqueous medium the radiological examination can be completed in a short time and surgery is not significantly delayed in urgent cases. Moreover, at operation the surgical procedure is in no way interfered with by the contrast medium, which can be easily removed by suction if necessary, and should peritoneal spillage occur the hazard of granuloma formation does not exist.

If a large accumulation of fluid is present proximal to an obstruction, considerable dilution of the contrast medium will occur and to obtain adequate opacification the use of solutions of at least 40% strength is suggested (Fig. 14).

Differentiation between mechanical obstruction and paralytic ileus can present considerable difficulty both clinically and radiologically when plain films alone are used, but is materially assisted by the use of a water-soluble contrast medium. The rapid arrival of the medium in the rectum without prolongation of the expected transit time, and the absence of any hold-up or distension at any proximal site in the bowel allows a complete mechanical occlusion to be excluded from the diagnosis (Fig. 3). In cases of an incompletely obstructing stenotic lesion there is no danger as with barium of the obstruction being made complete; but on the other hand, since the low viscosity of the soluble media allows them to traverse narrow channels freely, the appearance of the medium in the distal bowel does not by itself necessarily exclude a partial obstruction. According to Epstein,<sup>4</sup> in cases of partial obstruction there is usually a prolonged transit time with evidence of retention of contrast medium in dilated bowel segments for a period of at least 3 hours. However, in some cases it may be impossible to distinguish with certainty between partial obstruction and paralytic ileus.

#### Absorption and Excretion of Soluble Media

In the earlier reports on the aqueous iodide oral contrast media these were sometimes described as 'non-absorbable'; that is, they were thought not to be absorbed from the gut. The term is clearly incorrect. Many workers have observed urinary excretion after oral ingestion of these media. Jacobson *et al.*<sup>5</sup> reported a urogram in 2 out of 45 cases. Lilienfeld<sup>7</sup> found observable urinary excretion in 5 out of 19 cases. Berman and Avnet<sup>8</sup> found 16 out of 42 infants demonstrated urinary excretion. In this series urographic excretion of soluble media was observed in 4 out of 52 cases where the urinary tract was radiographed, but

in one of these the iodide medium was absorbed from the pleural surface and not from the gut (Fig. 12B).

Undoubtedly, like barium, the major portion of the ingested iodide medium is excreted in the faeces. However, Lilienfeld<sup>7</sup> found after giving radioactive 'urokon' (sodium acetate) by mouth to 25 normal individuals that one-

*Fig. 10.* After oesophagectomy for oesophageal carcinoma and oesophago-gastric anastomosis. Oral hypaque swallow shows no obstruction at anastomosis and no leakage from suture line. Female patient aged 61 years.

*Fig. 11.* Carcinoma of oesophagus. Postoperative film after attempt to introduce a Souttar's tube. Swallow of 50 ml. of 20% oral hypaque. Tube is too highly placed, its lower end being within the tumour mass. The gullet remains totally obstructed. Marked dilation above the neoplasm.

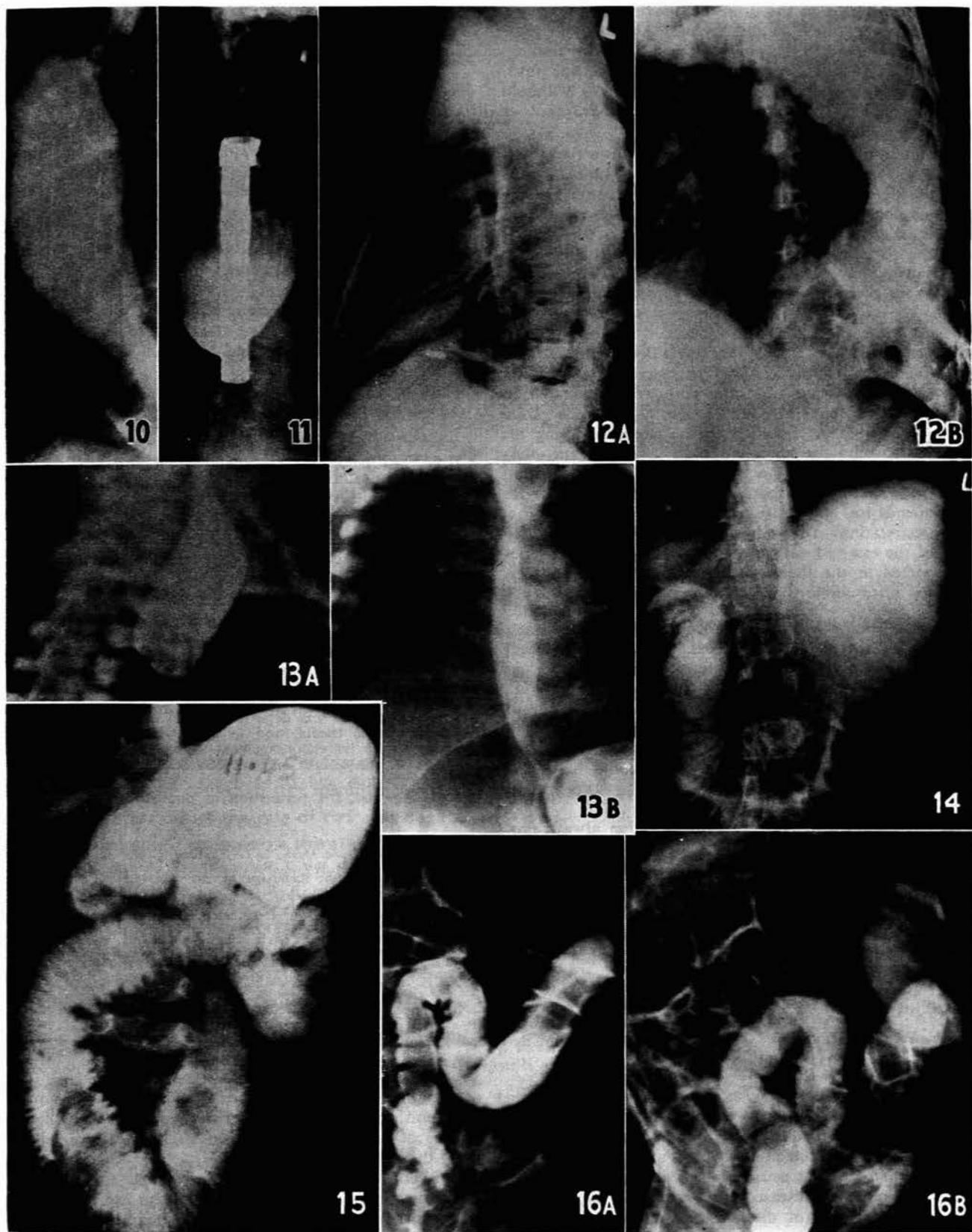
*Fig. 12.* Male aged 18; stabbed left lower chest posteriorly. Empyema developing on the haemopneumothorax treated by intercostal drainage. A: Left lateral chest radiograph demonstrating left pneumothorax and suggesting a diaphragmatic hernia (as also did the postero-anterior chest radiograph). Food particles were found to emerge from the intercostal tube. B: Oblique view after oral hypaque swallow. Massive spillage of contrast medium emerges from the diaphragmatic hernia to flood the pleural space. A pyelogram was observed. No untoward effects attributable to the contrast medium were evident. At operation two stab holes were found in the gastric fundus, which was herniated through a rent in the left hemidiaphragm. Good recovery after surgical repair.

*Fig. 13.* Oesophageal atresia. Excessive dribbling from the mouth since birth. The postero-anterior plain film 21 hours after birth showed air in the blind upper oesophageal pouch and air-filled stomach and bowel, indicating a fistulous communication between the trachea and lower oesophageal segment. A: Lateral spot film of upper oesophageal pouch opacified by 5 ml. of 20% oral hypaque injected *via* catheter. B: Appearance 3 weeks after operation. 20% oral hypaque in milk formula by bottle feed. There is slight narrowing at the anastomosis. No hold-up or leakage. Lungs clear. Uneventful recovery.

*Fig. 14.* Duodenal obstruction. Male aged 36 years. Recent history of vomiting, abdominal distension and loss of weight. Supine plain film of abdomen showed enlarged air-filled stomach. An erect film showed also a large quantity of fluid in the stomach. Figure shows supine film after drinking 100 ml. of 40% oral hypaque. Grossly dilated stomach and duodenum. Medium held up to the left of the spine at the junction of the third and fourth parts of duodenum. None passed this point up to 2 hours. The patient died before laparotomy could be done. Permission for autopsy refused.

*Fig. 15.* Infant presenting with profuse vomiting. 3 months previously it had undergone operation for reduction of an intussusception. Film after oral-hypaque meal showing total hold-up in jejunum with marked proximal dilation. A film taken 1 hour later showed no advance of the contrast medium. Diagnosis: Complete mechanical obstruction. At operation a band tightly obstructing the jejunum was severed.

*Fig. 16.* Infant aged 2½ months. Plain films of the abdomen showed gaseous distension of small bowel, gross dilation of proximal three-quarters of colon and collapsed sigmoid, suggesting an obstruction in the lower descending colon. A: 300 ml. of 10% hypaque solution given *per rectum*. The rectum and sigmoid are well opacified. The medium is held up at the junction of sigmoid and descending colon. B: The pressure was raised slightly (note distension of rectum) and a small quantity of hypaque now negotiates the obstruction and enters the widely dilated splenic flexure. The sudden transition in calibre is well shown. Parents refused operation. At autopsy diagnosis of Hirschsprung's disease confirmed.



fifth was excreted in the urine in the first 24 hours and 3% was concentrated in the thyroid. Although no toxic effects were noted in the present series the above findings suggest that systemic toxicity remains a theoretical possibility and it is probably a wise precaution to withhold aqueous iodides from patients with hyperthyroidism or with severe renal or hepatic insufficiency.

An interesting finding in this series has been the observation in 3 cases of a small residue of fine granular particles of high, almost metallic, density persisting in the stomach long after the bulk of the oral hypaque has moved on or has been eliminated entirely (Fig. 2B). In one case the particles were distributed in stomach, duodenal cap, and duodeno-jejunal flexure (Fig. 1B). Their density was always greater than the original density of the medium in the stomach. This phenomenon was also noted by Shehadi,<sup>9</sup> who was at a loss to explain it, and by Epstein,<sup>10</sup> who attributed it to precipitation or flocculation of the oral hypaque by the acid gastric secretions. Lilienfeld<sup>7</sup> showed that hypaque and urografin are precipitated *in vitro* by strong mineral acids, which suggests the possibility of *in vivo* precipitation in the stomach. Using his tracer-dose technique he found a 40% decrease in intestinal absorption of oral aqueous iodides on alkalinizing them with sodium bicarbonate before administration. He recommends this procedure as a means of preventing gastric precipitation. This is probably unnecessary, for in none of the cases of gastric precipitation seen in this series or reported in the literature were any untoward effects observed attributable to precipitation.

#### EXAMINATION OF THE COLON BY ENEMA

Soluble media are ideal for the examination of the infant colon, particularly if a stenotic lesion such as Hirschsprung's disease (Fig. 16B) is suspected. Barium ought always to be withheld in such cases in favour of an aqueous iodide solution, for the danger of barium impacting on the proximal side of a narrow area in the colon is real. The barium tends to become hard and inspissated because the water in which it is suspended is removed by the colonic mucosa.

In infants a 10% hypaque enema solution always provided adequate density (Fig. 16A). Infants varied in their ability to evacuate the enema, some being disinclined, perhaps because of the lack of a bulk stimulus. In others evacuation was complete, leaving no residual opaque medium adherent to the colonic mucosa—a slight disadvantage since double-contrast air studies are not possible in such circumstances.

Colonic fistulae were readily demonstrated by the use of iodide solution. In these cases the low viscosity of the medium is a distinct advantage.

#### CONCLUSION

Judiciously used in selected cases where barium is specifically contraindicated, soluble media have been found to be a valuable aid in the examination of the gastro-intestinal tract.

In our experience the chief uses for the soluble iodide media have been:

1. In all contrast studies of the alimentary tract in young infants
2. In oesophageal obstructions or fistulae
3. In intestinal obstructions
4. For postoperative examination of the alimentary tract
5. Wherever there is a need to obtain a rapid follow-through examination
6. In intestinal fistulae.

#### SUMMARY

The situations where the use of barium in the alimentary tract is contraindicated are discussed. A trial of 135 examinations in which soluble iodide contrast media were used in selected African patients is described and the advantages and disadvantages of these media are enumerated. Soluble media are considered to have an important role to play in paediatric radiology, in the special problems of the oesophagus in the African, in intestinal obstructions, and in the postoperative examination of the alimentary tract.

To Dr. R. J. Thomas, of Winthrop Laboratories (S.A.) (Pty.) Ltd., my thanks are due for helpful assistance and for generous supplies of oral hypaque. I am grateful to my fellow radiologists in this department who cooperated with me in using soluble media, and to Dr. H. Clain, head of the department, for his encouragement and support. I should like to thank the physicians and surgeons who referred cases for their cooperation and Dr. I. Frack, Superintendent, Baragwanath Hospital, for permission to publish.

#### REFERENCES

1. Sher, S. (1962): Personal communications.
2. Lowman, R. M. and Davis, L. (1958): *Surg. Gynec. Obstet.*, **106**, 567.
3. Samuel, E. (1960): *Brit. J. Radiol.*, **33**, 86.
4. Epstein, B. S. (1960): *Radiology*, **74**, 581.
5. Rubin, R. J., Ostrum, B. J., and Dex, W. J. (1960): *Arch. Surg.*, **80**, 495.
6. Jacobson, H. G., Shapiro, J. H., and Poppel, M. H. (1958): *Amer. J. Roentgenol.*, **80**, 82.
7. Lilienfeld, R. M. (1959): *Acta radiol. (Stockh.)*, **51**, 251.
8. Berman, C. Z., and Avnet, N. L. (1960): *Brit. J. Radiol.*, **33**, 92.
9. Shehadi, W. H. (1960): *Amer. J. Roentgenol.*, **83**, 933.
10. Epstein, B. S. (1957): *Ibid.*, **78**, 694.