The Gastro-camera

G. D. HADLEY,* M.D., F.R.C.P.

[WITH SPECIAL COLOUR PLATES]

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This article is concerned with a new technique for gastric photography. For many years it has been possible, by attaching a suitable camera to the proximal end of the flexible gastroscope (or fibroscope), to record the gastroscopic field, and the development of electronic flash illumination has overcome the problems of loss of light in the shaft of the instrument and greatly improved the results. This system, however, remains photography through a gastroscope; the technical difficulties and hazards of gastroscopy are still present, and the only object achieved is a permanent record of the gastroscopic impression.

The principle involved in the Olympus gastro-camera is entirely different, as the camera itself is intragastric. Its transmitting-tube is hollow and carries only the control cables operating the camera. It can thus be made thinner and more flexible than the gastroscope.

We have nearly two years' experience of this camera, and the number of examinations approaches 300.

The gastro-camera described here was conceived some 15 years ago in Hayashida's department at the University of Tokyo, and was evolved in close association with the Olympus Optical Company. Much of the earlier development and research work was carried out in Professor Tasaka's department, and their first publication appeared in 1950. Since then the camera has been greatly improved and its use in Japan is now widespread. Of Japan's 4,000 hospitals 825 are using the instrument, and nearly 20,000 patients monthly undergo gastro-camera examination. In 1959 the Japan Endoscopic Society was founded: this society meets yearly and publishes monthly the *Journal of the Japan Endoscopic Society*. An extensive literature has grown up in Japan, but unfortunately it is almost inaccessible, being written exclusively in Japanese, though in the last year abstracts of most of the articles in the journal have been printed in English. No doubt by reason of the language difficulty, knowledge of the gastro-camera has been slow to extend outside Japan; in fact, very little is known of it in the western hemisphere, and the number of gastro-cameras in use outside Japan is very small indeed.

Gastric disease is very prevalent in Japan, and carcinoma of the stomach is the commonest malignant tumour. Its early diagnosis has posed the Japanese a diagnostic challenge to which they have actively responded. Their radiology is not backward, but they do recognize its limitations, particularly in the diagnosis of early gastric cancer, and therefore they have for years been keenly interested in techniques of direct examination of the gastric mucosa. National characteristics are here again important. The Japanese are small highly strung people with little throats and large teeth, which they tend to keep to late in life. Any gastroscopist will immediately realize the implication of this—that even with the relatively slim and flexible Woolf-Schindler gastroscope large-scale examination of such a population would be impossible. The failure rate with the superior Hermon-Taylor modification would be high, and, even in expert hands, the risks not inconsiderable. The Japanese regard the flexible gastroscope as an unwieldy, painful, and dangerous instrument, and certainly in their own country they are right. These were the reasons which prompted them to devise another

method of direct examination, safer and easier than gastroscopy and capable of extensive and widespread use.

The Instrument

The current model for routine clinical use is the Mark V. The camera unit is mounted at the end of a double-coil steel-wire tube covered with vinyl, down which the controls pass (Fig. I). The illuminating flash bulb is immediately distal to the camera (Fig. II, a). This is a filament bulb operated by a condenser discharge at 38 volts D.C. from a separate transformer. The extreme tip of the instrument unscrews to receive the pre-packed film roll, which is contained in a metal cassette. The end of the film strip is perforated for attachment to a metal tongue at the end of the film winding-wire. The tip is perforated for passage of the air required for insufflation, and a rubber diaphragm valve prevents seepage of gastric contents backwards into the film-container. The camera is of fixed focus and contains neither shutter nor iris (F17, $f=3.6$ mm.). The film used is Anscochrome tungsten, ASA32, the strip being about 300 mm. long and 5 mm. wide. Thirty-two circular photographs of 5 mm. diameter are taken at each examination.

The controls are operated from a rectangular metal box at the upper end of the flexible shaft (Fig. III). On one side is the circular film-winder with frame-counter window adjacent. The exposure switch is set on the top of the control box, and has an arrangement by which it can be disconnected from the film-winder if necessary during the examination, so that the bulb

FIG. I.—The Mark V gastro-camera. (Scale 1/5.)

* Physician, the Middlesex Hospital, London.

can be illuminated as often as required for localization without winding the film on between each flash.

On the reverse side of the box is another wheel which operates a device by which the camera can be angled up or down by 35 degrees (Fig. II, b).

The diameter of the camera unit is 11.5 mm. and of the flexible shaft 8 mm. Only the camera unit itself is rigid. The shaft is extremely flexible but is axially rigid—that is, rotation of the control box by 15 degrees rotates the camera also by 15 degrees.

There is no view-finder, but this is less of a disadvantage than would appear. The examination is conducted in a darkened room, and the flash emitted by the bulb is of such intensity that it can very easily be seen even through an obese abdominal wall. The depth of insertion is gauged by the maximal light intensity, and the extent of gastric insufflation is judged by the area of diffuse glow visible around the flash.

FIG. II.—(a) The camera unit. (b) Camera angled 30 degrees in the "down" position. (Scale 4/5.)

FIG. III.—Control box. (Scale 3/4.)

Examination

The fasting patient is premedicated and the throat anaesthetized. At present we use an omnopon-scopolamine premedication with an amethocaine lozenge for local anaesthesia, exactly as for gastroscopy. This is perhaps unnecessarily heavy and may be modified. In Japan no sedation is given and out-patients go home immediately after the examination. The examination is, however, often more easily and quickly conducted and is less unpleasant for the patient if some premedication is given.

The camera is normally passed with the patient lying comfortably in the left lateral position with the head on a pillow and the neck partially flexed. Some prefer to pass it with the patient lying supine, but in any case passage is nearly always accomplished without difficulty, and the fact that extension of the neck is not required at any stage of the examination is a great advantage.

The camera having passed the cardia, the patient turns to lie supine, the head remaining supported by a pillow (Fig. IV). The room is then semi-darkened and the stomach gradually insufflated. The light is now flashed repeatedly and the instrument introduced slowly to full depth. It is often found that the introduction of the camera through the cardia causes temporary gastrospasm; the stomach is for a while difficult to insufflate, and the instrument will not pass easily inside the stomach. When this happens little or no light is visible through the abdominal wall. Patience, slow insufflation, encouraging words, and abdominal massage generally overcome this difficulty in a short time. It is, however, useless to proceed until spasm has been overcome and the stomach is adequately inflated. Photography can now begin. Normally we start with the instrument at full depth in the pyloric antrum and work gradually backwards to the cardia, taking three or four exposures at different degrees of rotation at each level and making use as required of the device which angulates the camera upwards and downwards, endeavouring to ensure as complete coverage of the stomach as possible.

FIG. IV.—The instrument in use.

X rays do not cause any detectable "fogging" of the colour film used in the gastro-camera. It is therefore possible to check the position of the camera fluoroscopically after it is in position in the stomach. We have not found it necessary to do this routinely. It increases the time taken for the examination, and x-ray equipment and staff may not always be available. We have, however, found it helpful, in improving and checking our technique, to arrange occasional gastrophotography sessions.

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PLATE 1.—Peristaltic wave approaching the pylorus (indicated by arrow). The mottled discoloration of the mucosa indicates atrophic gastritis. The dead-white dots are highlights.

PLATE 2.—A normal stomach. (1) Angulus. (2) Anterior wall. (3) Pylorus.

PLATE 3.—Normal stomach of short transverse type with broad ill-defined angulus. A peristaltic wave approaches the pylorus.

PLATE 4.—Advanced atrophic gastritis. Submucosal blood-vessels are clearly visible through the pale thin mucosa. The trace of fresh blood is probably traumatic.

PLATE 5.—Gastro-enterostomy. Most of the stoma is visible on this frame. A marginal ulcer is seen at the arrowed site.

PLATE 6.—Gastric polyposis. The scarring is the result of previous local excision. The polyp arrowed is ulcerated on its summit.

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PLATE 7.—Large ulcer crater just distal to angulus. Its regular oval shape and clean base favour a benign ulcer, but the raised nodular edge raises suspicion of carcinoma.

PLATE 8.—The same ulcer as Plate 7 three weeks later. Almost complete healing.

PLATE 9.—A chronic benign gastric ulcer in a healing phase. The radiating folds indicate scarring.

PLATE 10.—(1) Angulus. (2) Shows an irregular ulcer with a raised nodular margin on lesser curve of antrum. A small ulcerating carcinoma.

PLATE 11.—Carcinoma. A large irregular ulcerated tumour projects into the lumen from posterior wall at angulus level.

PLATE 12.—Large benign tumour (neurofibroma). A deep ulcer is present on the summit.

using x-ray control; and certainly when photography of the cardia and fundus is particularly necessary it is more readily achieved in this way.

The time required for the examination varies. It is, however, quicker and easier than gastroscopy, and with one couch and one camera ten patients can be examined in a session. At the Tokyo University Clinic two doctors operate simultaneously and 16 to 18 patients occupy one session. A certain amount of stagecraft is necessary to manage a clinic of this size smoothly and efficiently.

Processing and Viewing

Processing must be done by an Ansco agent (Colour Centre Cine Ltd., Farnham Royal, Slough, Bucks), and, as the method is not standard, special arrangements have to be made. Our films exposed on Thursday morning are usually returned on Saturday morning.

Viewing.—The set provided contains a small hand-viewer ($\times 10$) which for individual use is perfectly satisfactory, but if it is desired to show and discuss the result with others it is of course imperative to project the film. It is not difficult to construct a holder for the film strip, which can then be placed in any good 35-mm. slide-projector. The resolving power of the gastro-camera lens is admirable, and film grain is the limiting factor in projection. It is, however, possible to project to dimensions suitable for a fair-sized lecture theatre without grain becoming obtrusive, and in a small room containing seven or eight people no difficulties arise. (The new Anscochrome film of ASA100 should considerably improve the grain.) Colour-rendering is excellent and compares well with the familiar gastroscopic appearance of the mucosa.

Results

It is important that too much be not expected from a new instrument of this type. The stomach remains a singularly difficult organ to visualize. It is a flabby organ, distensible only to its possessor's tolerance, hopelessly asymmetrical, subject to great variation in size and shape, and prone to distortion by spasm, disease, or surgical mutilation. Gastric endoscopy was never a rival to radiology, but it has always offered an additional means of expanding and amplifying radiological findings, and not infrequently this is of great importance. It should be carried out very much more often than is the case at present in this country, but the endoscopist needs to realize at the outset that patience and perseverance are required to carry out large numbers of not particularly informative examinations before the occasional dramatically valuable finding comes to light. This was always so with gastroscopy, and it remains so with gastrophotography.

Coverage of the stomach is not always complete. One does, however, expect to obtain good photographs of the pylorus and pyloric antrum (including its lesser curve), the incisura, and the lower half of the body of the stomach. It is much more difficult to obtain reliable photographs of the upper half of the stomach, and that particularly awkward area of the upper posterior wall is no easier to photograph than to inspect gastroscopically. The cardia itself and the fundus above the cardia, which are never visible with the gastroscope, can sometimes be photographed very well. To do so one has to acquire the technique of performing a U turn in the stomach so that the tip of the instrument is diverted upwards. The camera then photographs the shaft of the instrument passing through the cardia, and most of the fundus and the upper lesser curve are also in these circumstances visible. This manipulation is easier to perform in the thin-bellied Japanese than in many of our London patients. Here it is best done with x-ray screening; with further experience we shall undoubtedly achieve it more often

than at present, and modifications that will result in the Mark VA gastro-camera (not yet in production) should also increase the predictability of this manoeuvre.

The virtues of the gastro-camera are many, and its vices few. Facts which are immediately apparent are the ease, certainty, and safety of the examination. In elderly and perhaps decrepit patients with stiff necks, cervical spondylosis, and fragile pharyngeal mucosa the gastroscopy rate depends on the boldness of the operator, and, rightly, many patients are rejected. In those in whom examination is carried out, hazards, though acceptable in skilled hands, do exist. Gastroscopy, however, is never a comfortable procedure and is often quite the reverse, partly because of the size of the instrument, and, even more so, because of the drastic extension of the neck so often necessary to obtain a full field of vision. Our first 250 examinations with the gastro-camera have included patients from 13½ to 82 years of age, one with ankylosing spondylitis, several with cervical disk disease, and some with various degrees of kyphoscoliosis. We have not rejected any patient, and on only two occasions have we failed to pass the instrument into the stomach and to secure photographs. No accidents have occurred and the great majority of our patients have tolerated the procedure with equanimity. Several have been examined on two or three occasions, and those who have previously endured gastroscopy are in no doubt which procedure they prefer. It is possible, moreover, to carry out gastrophotography in the consulting-room. An adjustable table is not a necessity and only one assistant is required.

Another great advantage is that it is comparatively easy to teach. Our registrars, over the years, are familiar with the exasperating brevity of the glimpses they are permitted during a gastroscopy, and are fully aware that if they want to learn to be gastroscopists they must virtually teach themselves. The gastroscopist himself must concentrate on what he is doing, and cannot afford to spend much time in demonstrating to others. On the other hand, the technique of use of the gastro-camera is not difficult to learn. Interpretation of the film is another matter, for without previous gastroscopic experience this does present difficulties; but again it is much easier to teach. To have a series of photographs projected which can be shown as often as necessary, discussed, and argued about is a very great advantage, and assistants learn more in a few weeks by so doing than in a year of self-taught gastroscopy.

In Tokyo, at the National Cancer Centre and also at the University Clinic, weekly meetings are held at which x-ray and gastro-camera films are shown side by side and discussed. They are a happy meeting-ground of clinician, radiologist, and endoscopist, and are stimulating to all parties.

On the debit side there is little to be said. One has to wait two to four days for the film to be processed. Sometimes the portion of the stomach that one particularly desires to photograph obstinately refuses to pose. Occasionally the most promising frames are spoiled by mucus or blood on the lens. Sometimes distortion of the stomach—by disease or operation makes satisfactory photography almost impossible. In these circumstances it is necessary to repeat the examination and to hope for better luck next time. At present the Olympus Optical Company has no agent in Europe, and servicing and minor repairs have to be undertaken by the owner. These are not particularly difficult, but a course of instruction from an Olympus technician is certainly desirable, and at present can be obtained only in Tokyo. It is understood, however, that an agency and repair shop is shortly to be set up in Hamburg.

Gastrophotography in Some Specific Problems

1. *The Post-gastrectomy Stomach.*—In these cases there is always difficulty in securing adequate insufflation, and full coverage of the gastric remnant is seldom possible. We have, however, been able to photograph the stoma and the peristomal

region of the stomach more frequently than we expected, and in several cases the instrument has passed through the stomach and good views have been obtained of the efferent loop jejunum. However, our present impression is that in this group of cases the gastroscope may prove to be more reliable than the gastro-camera.

2. *Pyloric Stenosis*.—Repeated washouts are singularly ineffective in cleaning the stomach, and photography is often spoiled by food residues. Nevertheless positive evidence of antral carcinoma has been obtained in several cases, and in two cases the stenosis has been shown to be associated with benign gastric ulcer remote from the pylorus.

3. *The Spastic and Irritable Antrum*.—Radiological evidence is often insecure in these cases, and photography has been valuable. By virtue of the great flexibility of the gastro-camera it is usually possible to obtain better views of the lesser curve of the antrum than can be achieved at gastroscopy. Some of these dubious antra appear to be entirely normal. In others a benign ulcer has been visible on or distal to the angulus. None so far has revealed carcinoma.

4. *"X-ray Negative Dyspepsia"*.—The ease and simplicity of gastrophotography have led us to employ this method frequently in these cases where we might have hesitated to carry out gastroscopy.

In our first 100 cases five gastric ulcers, invisible at barium-meal examination, were shown.

5. *The Suspicious Gastric Ulcer*.—Short of histological examination there is no method of investigation (including laparotomy) which can guarantee to distinguish between benign and malignant gastric ulcer. Nevertheless with experience endoscopic mistakes are few, and, provided that good photographs of the ulcer and the surroundings can be obtained, diagnostic accuracy compares favourably with radiological assessment and also with surgical opinion at laparotomy.

In elderly patients, who should be spared extensive gastrectomy whenever possible, the information gained by gastrophotography has often been most valuable.

6. *Gastroduodenal Haemorrhage*.—In the early diagnosis of the source of haemorrhage the delay in film-processing makes the gastro-camera inferior to the gastroscope.

Conclusions and Summary

The Olympus gastro-camera is an instrument of practical value in the diagnosis of gastric disease.

The safety and relative simplicity of its use and the ease with which the technique can be learned, as compared with gastroscopy, suggest that its employment in this country should be extended.

The instrument is described and the technique of its use outlined.

Its application to specific problems of diagnosis is discussed.

Those who do acquire the instrument should use it freely both in in-patient and in out-patient work.

I wish to record with gratitude my thanks to Professor Yawara Yoshitoshi for facilities extended to me to work in his department at the University of Tokyo and to Dr. Hirohumi Niwa, Dr. Taddeo Sakita, and their colleagues for personal help both there and at the National Cancer Centre.

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Effect of Periodic Dialysis on the Peripheral Neuropathy of End-stage Renal Failure

F. I. D. KONOTEY-AHULU,* M.B., M.R.C.P., M.R.C.P.GLASG., D.T.M.&H.; ROSEMARIE BAILLOD,* M.B., B.S.;
CHRISTINA M. COMTY,* M.B., B.SC., M.R.C.P.ED.; J. R. HERON,* M.B., M.R.C.P.ED.;
STANLEY SHALDON,* M.A., M.D., M.R.C.P.; P. K. THOMAS,* M.D., B.SC., M.R.C.P.

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Although in performing periodic haemodialysis the aim is to achieve the fullest possible degree of rehabilitation, this may be hindered by peripheral neuropathy (Murray *et al.*, 1964). This syndrome was recognized by Osler (1892), and recently has been given much prominence by the advent of chronic haemodialysis (Hegstrom *et al.*, 1961, 1962; Locke *et al.*, 1961; Asbury *et al.*, 1963; Funck-Brentano and Vantelon, 1963; Lindholm *et al.*, 1963; Shaldon *et al.*, 1963; Barber *et al.*, 1963; Gonzales *et al.*, 1963; Versaci *et al.*, 1964; Shaldon, 1965), particularly as in some patients the neuropathy is brought to light (Hegstrom *et al.*, 1961; Burnell *et al.*, 1963) or made worse in the early period of a chronic dialysis programme (Hegstrom *et al.*, 1962; Burnell *et al.*, 1963).

This communication describes observations on the clinical features of uraemic neuropathy occurring in 20 patients

currently receiving regular dialysis therapy, together with studies of nerve conduction.

Material

Twenty patients, 13 men and 7 women (age range 17 to 57 years), with end-stage renal failure were studied (Table I). Renal failure was due to chronic glomerulonephritis, chronic pyelonephritis or polycystic kidneys. Patients with renal failure due to multiple systemic diseases such as diabetes mellitus, amyloidosis, or systemic lupus erythematosus were excluded. Fifty per cent. of patients had malignant hypertension at the start of treatment. All patients were suffering from clinical end-stage renal failure, with marked biochemical impairment of renal function (Table II). The average pretreatment blood urea was 394 mg./100 ml. (262-756 mg./100 ml.) and creatinine clearances were 5 ml./min. or less.

* From the Renal Unit and Department of Neurology, The Royal Free Hospital, London.