REFRACTING GASTROSCOPE

COLOR MOVING PICTURE

BY

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Photography by the use of endoscope was done in rapid succession since the 19th century. Holinger (1946) succeeded in taking a color photograph of the trachea and esophagus and Mōri (1956) reported on color photograph of an embryo in the uterus using hysteroscope. From olden times there were observed plans to take photographs of the changes of the gastric mucosa with a gastroscope also and record the findings obtained. The persons first to take photographs of the inside of the stomach were Lange & Melzing (1898). They formed the basis of gastroscope by attaching a camera on the end of a rubber tube and inserting it inside the stomach. The person who attached a camera on to the eyepiece of the gastroscope and take photographs of the inside of the stomach was Eishner (1926) but it was not a satisfactory one. Henning (1931) made possible the photographing of ordinary black and white pictures by attaching a camera to Schindler's rigid gastroscope. Using Schindler's rigid gastroscope he with Keilback (1937) succeeded in taking rather satisfactory color photographs. Hull (1940) took ordinary black and white photographs with a flexible gastroscope. The persons who made possible the photographing of color pictures with a flexible gastroscope were Segal and Watson (1948). In this case they supplemented the lack of sufficient light by the following three points: first the lens system of the gastroscope was made lighter by the lens coating and by using a high voltage of 80 volts for the electric lamp of the gastroscope; furthermore, a short focus lens was adapted for the gastroscope. Nelson (1950) improved this further. Using an electronic flash as a light source, Debay and Housset (1956) emphasized, made it easy to manipulate and safe and clear picture could always be taken. By using this camera Keever and Barborka (1959) took color photographs with an instantaneous high voltage of 180 volts. However, up to the present there is no report of success in taking color moving pictures. In photography there is the advantage of observing dynamically the physiology and pathology in clinical medicine.

By devising a polyethylene vinyl chloride outer tube the authors invented in 1957 a refracting gastroscope, which can be used easily and also without danger. Compared to the flexible gastroscope, with this refracting gastroscope there are much less blind area in the stomach. From the structure of the gas-
troscope and the anatomical shape of the stomach it is considered only natural that this refracting gastroscope is superior in observing especially the cardiac region. Moreover, it can be said that by the use of a back pillow the manipulation of the gastroscope became very easy and the pain felt by the patient is less than the flexible gastroscope. Historically the flexible gastroscope was built later than the rigid gastroscope but according to the author's experience the refracting gastroscope is by no means impossible to use at least in the Japanese of their physique; it supplements the defects of the flexible gastroscope and possesses many advantages.

The authors made great efforts to improve this gastroscope and in the spring of 1958 were able to take color pictures. In the summer of the same year the authors took color moving pictures of the gastric mucosa and in the autumn of the same year made a report before the annual meeting of the Japanese Practical Surgeon Society but it was not a satisfactory one. In July, 1959 the authors completed a gastroscope with a water-cooled light source and with it it was possible to take a satisfactory color moving picture of the inside of the stomach. This moving picture was shown before the Gastrocamera Society on November 7 of the same year. This is considered to be the first of the kind in the world.

**Apparatus**

Taking moving pictures of the inside of the stomach with a gastroscope can be considered by dividing the gastroscope, as in photographing with other endoscopes, into the movie camera, the film and the lense system of the gastroscope. Of these the characteristic point of the gastroscope is that the lense system of the gastroscope can not be made short or large. For this reason the decrease of the amount of light is very large. There is a limit also to the size of the electric lamp as a light source, it being impossible to have a light of a certain brightness. This point presents difficulty in taking color moving pictures with a gastroscope. Therefore, the authors took pains to have the lense system of the gastroscope as bright as possible and prevent to the minimum the decrease of the amount of light. At the same time improvement was made on the electric lamp for photographing and it is considered that together with this the progress made in color film made possible the success of photographing color moving pictures of the inside of the stomach. Below will be stated the method used by the authors.

**Camera:** The movie camera used by the authors was a 16 mm cinekodak with a few improvements made. The speed of photographing was 8 frames per second. For this reason the shutter speed was approximately 1/16 second. Photographing was done with the iris diaphragm fully open (Fig. 5).

**Film:** The film used was the tungsten type of Superanscochrome (ASA 100), the film being intensified and developed to ASA 200. As an ordinary film there is a tri-X film of ASA 200. As this film can be intensified and developed to ASA 1200, it can be used as a film with a still higher sensitivity. On this point photographing with ordinary black and white film is very easy.
Fig. 1. Gastroscope for photographing moving pictures.

**Lens:** The refracting gastroscope is 84 cm long with the outside diameter 7 mm. Inside of this are 20 pieces of F=1:11 lenses with a focus of 49 mm and an effective diameter of 4.5 mm and 2 prisms (Fig. 1). The light gradually decreases as it passes through these lenses. One is due to the adsorption of light by the lens and the other due to about 7~8% of the light being reflected as it passes through the surface between the air and the lens. The coating of the lens is used as a means of obliterating a part of this reflected light and increase the transilluminating light. As stated before, Segal and Watson (1943) reported on coating of the lens and on making possible of making the lens system of the gastroscope very light. The authors also used coated lenses except for the objective piece and prism. The point to which the authors paid attention was the special lens coating for the purpose of preventing as much as possible the decrease of color temperature while passing through the lens system of the gastroscope. For this reason it is considered that the reproduction of the color is fairly close to natural.

As known by everyone the brightness of the lens is expressed by the value (F) of dividing the focal distance by the effective diameter. Therefore, the smaller the F is, the brighter is the lens. It has been stated before that Segal & Watson made the lens system bright by using a short focus lens. Up to the present a few of the gastroscope used lenses with a comparatively long focal distance. At present efforts are being made to make the lens system of the gastroscope bright by using many lenses with a short focal distance. As shown in Fig. 2 the refracting gastroscope is composed of many lenses.

![Fig. 2. Structure of the lenses of the refracting gastroscope.](image)

**Lamp:** In endoscopes ordinarily vacuum electric lamps are used, which do not cause convection. As gas-filled electric lamps reach a fairly high temperature there is the danger of causing burns to the organs. With a refracting gastroscope a single vacuum electric lamp is sufficient for the purpose of observation only but for taking color photographs two vacuum electric lamps connected vertically are used. However, in taking color moving pictures satisfactory results can not be obtained with only the vacuum electric lamp. For this a gastroscope of the type using a gas-filled electric lamp with the light source being cooled by the warm water surrounding it was built (Fig. 3, 4). The electric lamp has a tungsten filament and is 15 mm in length and 4 mm in external diameter.
Fig. 3. (a) Tip of the gastroscope for photographing moving pictures.  
(b) View after outer tube is taken off.

Fig. 4. Tip of gastroscope for photographing moving pictures.

Inside it is argon gas and the voltage is 8 volts and the watt 18 watts. When using this electric lamp, a color temperature of 3200°K can be produced with a low voltage of 15 volts and an illumination of about 5000 luxes can be obtained at a distance of 4 cm. For the purpose of cooling this electric lamp by circulating a warm water around it, an outer pipe was made from resin of acrylic acid derivation. This material passes light more than the other plastic materials and the great advantage of it is its insulating property. However, as the radiation heat could not be prevented by this alone, a metal plate was placed in the inside of the acrylic resin except the window of the electric lamp. In order to circulate the warm water between the outer tube and the electric lamp two pipes of 1 mm in inside diameter was arranged parallelly with the optical tube. It was devised so as to have one end of this tube connected to the irrigator near the eyepiece by a vinyl tube and the circulating warm water flow out from the other end. It is best to have the temperature of the warm water circulating around the electric lamp slight higher than the body temperature. If cold water is used waterdrops form on the surface of the lense
and make the image obscure. The essential thing is to stop the rise in temperature of the electric lamp at a point below where it would cause burns rather than to cool the electric lamp. As there is still some radiation heat in the region of the window of this electric lamp cooling apparatus, it is best to cease taking picture temporarily after about ten seconds of photographing and then photographs again (Fig. 5).

**Method**

The most important thing in taking moving picture is to maintain the distance between the surface of the lense of the gastroscope and the object on the gastric mucosa at 3 to 6 cm, because within this range the most appropriate illumination can be obtained. By this, in general a satisfactory result can be obtained.

As there is, up to the present, no reports on the moving picture of the inside of the stomach by a gastroscope, a comparison will be made with the color photography by other gastroscope. Segal and Watson (1948) photographed with a Kodachrome film Type A (ASA 16) at a voltage of 80 volts with an exposure of one-half second. Nelson (1956) photographed with a
Kodachrome film Type A or Ectachrome film (ASA 32) at a voltage of 50–60 volts with an exposure of one-half to one second. Miura (1959) photographed with a gastrocamera using an Anscochrome film (ASA 32) or Ectachrome film Type F at a voltage of 36 volts with an exposure of 1/17 second. Keever and Barborka (1959) photographed with a Kodachrome film Type F (for flash use) at an instantaneous voltage of 180 volts. However, it is reported that with this continuous photographing is impossible, photographing being done at intervals of 10 to 20 seconds. The above is in regard to color photography. The author’s present method color photography is as follows: photographing is done with a Superanscochrome film intensified and developed to ASA 200 at a voltage of 16 volts with an exposure of 1/16 second. By this method there is the advantage that the voltage in very low and with no danger (Fig. 6). Hereafter, it is possible to take moving picture of the inside of the stomach at 16 frames per second.

CASE REPORTS

Color moving picture of the gastric mucosa of 7 cases using the gastroscope described above will be shown. The first case is the findings of the normal gastric mucosa. The second case is the findings before and after operation for the cancer of the stomach. The third case is a case of severe superficial gastritis accompanying pyloric stenosis due to the cancer of the stomach. The fourth and fifth cases are the findings of an acute gastritis of the remaining part of the stomach observed during postoperative obstruction to passage. The sixth case shows the movement in the region of anastomosis on the 15th day after operation. The seventh case shows the condition in the region of anastomosis of the remaining part of the stomach showing postgastrectomy syndrome.
Case 1. K. E. 32 years old, male, Adhesion of the greater omentum:

Patient complained of discomfort and dull pain in the abdomen since October, 1958 and the stool became diarrheal during constipation. The gastric juice showed hypacidity and by cholecystography the gallbladder was not visible. X-ray finding of the stomach revealed nothing abnormal in particular (Fig. 7). For the purpose of detailed examination the patient was admitted on July 1, 1959. By gastroscopic examination there was observed foams attached to the gastric mucosa but no other abnormal findings were observed (Fig. 8). On July 14 an abdominal operation was performed. The greater omentum was seen being adhered to the cecum and adhesiotomy was performed. After the operation the course was uneventful and the patient was discharged. In this case the gastric mucosa showed a normal finding.

![Fig. 7. Roentgenogram of the stomach of patient with adhesion of the greater omentum, Case. 1.](image)

No abnormal finding observed.

Case 2. T. D. 44 years old, female, Cancer of the stomach:

Since about the summer of 1957 the patient complained of pyrosis and gradually became to complain of upper abdominal pain, loss of appetite and general fatigue. As the upper abdominal pain increased the patient was admitted in September, 1959. At the time of admittance a fist size hard rough uneven
Fig. 9. Roentgenogram of patient with cancer of the stomach, Case 2.

(a) Shows filling defect in the pyloric region.

(b) Passage good in the region of gastrojejunostomy after operation.
tumor with tenderness in the upper abdomen was palpated. X-ray findings of the stomach revealed a filling defect in the pyloric region (Fig. 9-a). By gastroscopic examination the Bormann II type cancer of the stomach was observed with the lesion extending to the cardiac side (Fig. 10-a). On October 1, 1959 subtotal gastrectomy (Billroth II method) was performed. From the tenth day after the operation the patient began to complain of sense of repletion of the abdomen and gradually complained of light nausea. On the second week after the operation the X-ray examination revealed a condition of no stenosis (Fig. 9-b). The gastroscopic finding on the 25th day after the operation showed on edematous swelling and light redness in the region of anastomosis but there was observed no acute inflammation in the body of the stomach (Fig. 10-b). From about the third week after operation the symptoms gradually improved and the patient was discharged.

Case 3. T.T. 51 years old, male, Cancer of the stomach:

From June, 1959 the patient complained of upper abdominal pain and the abdomen gradually became distended and as the patient began to vomit he was admitted on October 10. A chick egg-sized hard tumor with tenderness was palpated in the upper abdomen. The gastric juice showed hypacidity. X-ray finding of the stomach showed a filling defect in the pyloric region (Fig. 11-a). By gastroscopic examination the body of the stomach was rough and uneven up to the cardiac end with marked redness and in places coated. A large amount of dirty stomach content was observed. This was a finding of a very severe superficial gastritis accompanying pyloric stenosis due to cancer of the stomach (Fig. 12-a). On October 27 an abdominal operation was performed. Cancer of the stomach and cholelithiasis were observed and subtotal gastrectomy (Billroth II method) and cholecystectomy were performed. The postoperative course was good and by gastroscopy gastritis was not observed at all on the 17th day after operation (Fig. 12-b). Also by the X-ray finding of the stomach on the 3rd week after operation obstruction to passage was not observed (Fig. 11-b) and the patient was discharged.

Case 4. Y.K. 32 years old, female, Duodenal ulcer:

From 1955 for 4 years the patient complained of abdominal pain, pyrosis and eructation. These symptoms gradually became severe and pains in the back began to appear. By the X-ray examination of the stomach deformity of the duodenal bulb was observed and a diagnosis of duodenal ulcer was made (Fig. 13-a). By the gastroscopic examination there were observed no specific findings (Fig. 14-a). The patient was admitted in April, 1959 and gastrectomy (Billroth I method) was performed. On the third week after the operation sense of repletion of the abdomen and vomiting was observed and thereafter for two weeks there were symptoms of light stenosis. By the X-ray examination of the stomach also a light obstruction to passage was observed (Fig. 13-b). By the gastroscopic examination on the 32nd day after operation centering around the region of anastomosis the stomach wall was coated, and it easily bled, revealing a light acute inflammation (Fig. 14-b). In this case the picture
(a) Shows filling defect in the pyloric region and pyloric stenosis.

(b) Passage good in the region of gastroanastomosis after operation.

Fig. 11. Roentgenogram of patient with cancer of the stomach, Case 3.
(b) Shows slight obstruction to passage in the region of gastrectomy stump, Case 4.

(a) Shows deformity of the duodenal bulb.

Fig. 13. Roentgenogram of patient with duodenal ulcer, Case 4.
was that of a light acute gastritis at the time of postoperative stenosis.

Case 5. K.O. 61 years old, male, Duodenal ulcer:

The patient complained of loss of appetite and sense of repletion of the abdomen from the first part of 1958. X-ray examination of the stomach showed deformity of the duodenal bulb and a diagnosis of duodenal ulcer was made (Fig. 15-a). By the gastroscope examination there were observed no specific findings but peristalsis was observed (Fig. 16-a). The patient was admitted in June, 1959 and gastrectomy (Billroth I method) was performed. From the 8th day after operation the patient complained of distension of the abdomen and on the 2nd week after operation there was nausea and vomiting once. Even by the X-ray examination of the stomach a light obstruction to passage was observed (Fig. 15-b). After this it improved gradually. By the gastroscope examination on the 18th day after operation in general there was redness of the entire body of the stomach and in places green coating was observed (Fig. 16-b). This case showed a picture of severe acute gastritis at the time of postoperative stenosis covering the entire part of the remaining stomach.

Case 6. M.K. 43 years old, male, Gastric ulcer:

The patient complained of upper abdominal pain and nausea from 1957 for 1 year and a half and these symptoms gradually increased. By the X-ray examination of the stomach a niche was demonstrated in the body of the stomach (Fig. 17-a). The patient was admitted in June, 1959 and gastrectomy (Billroth I method) was performed. After the operation there was no obstruction to passage and the course was uneventful (Fig. 17-b). By the gastroscope examination on the 15th day after operation the region of anastomosis was edematous and swollen and even by sending in air the degree of opening was very small. The autokinesis in the stoma was not observed. Foamy intestinal juice was seen to flow back into the stomach from the stoma (Fig. 18). This case showed the condition of the region of anastomosis.

Case 7. N.M. 21 years old, male, Stomach showing postgastrectomy syndrome:

From about August, 1956 the patient complained of upper abdominal pain which increased gradually. By the X-ray examination of the stomach a diagnosis of duodenal ulcer was made. In November of the same year gastrectomy (Billroth II method) was performed. From about one-half year after operation the patient complained of discomfort in the left upper abdomen extending to the back and noticed an increase in saliva. These symptoms appeared repeatedly at intervals of 2 to 7 symptomless days and there was no increase in severity. The gastric juice showed hypacidity. By the gastroscope examination in November, 1959 the region of the anastomosis was in an open state and no active opening and closing movement was observed. The passive opening and closing movement was also not distinct. Ulcer were not observed in the region of the anastomosis and in the jejunum (Fig. 20). By the X-ray examination in December, 1959 the barium passed immediately into the intestine without
Fig. 15. Roentgenogram of patient with duodenal ulcer, Case 5.

(b) Shows considerable obstruction of passage in the region of gastrogastricostomy after operation.

(a) Shows deformity of the duodenal bulb.
(a) Shows niche in the body of the stomach.
(b) Passage through the region of gastrostomosis after operation is bad.

Fig. 17. Roentgenogram of patient with gastric ulcer, Case 6.
(a) Barium does not remain in the stomach, passing immediately into the intestine.

(b) Barium disappears shortly after swallowing. The stoma of the anastomosis is considerably large.

Fig. 19. Roentgenogram of patient with postgastrectomy syndrome, Case 7.
being retained in the stomach, and accumulated in the small intestine in the pelvis (Fig. 19). In this case the condition of the anastomotic region of the remaining stomach showing postgastrectomy syndrome.

**CONCLUSION**

The structure of the refracting gastroscope with water-cooled light source and directions for using this gastroscope were described. Interesting findings obtained by photographing with this gastroscope were also described and the color moving picture film of the inside of the stomach was shown.

**REFERENCES**


