

## Progress report

# Fibreendoscopy of the intestines

Since the introduction by Hirschowitz in the year 1958 of fibre optics into the field of endoscopy<sup>1</sup>, oesophagoscopy and gastroscopy have attained an undreamed of popularity as diagnostic methods. It is now possible to observe directly all the regions of the stomach, to photograph and film them, and to obtain biopsy samples under direct visual control. Colour television makes possible the demonstration and also the simultaneous evaluation by several observers of what can be seen in the fibrescope. It was quite obvious that with the aid of fibre optics, the earlier limitations of gastroenterological endoscopy—to oesophagus, stomach, and sigmoid colon—could be overcome.

### **Duodenoscopy**

The success rate of 50% claimed by Hirschowitz and his co-workers<sup>2</sup> for the examination of the duodenum with the Hirschowitz fibrescope was not confirmed by other authors<sup>3</sup>. In 1966, however, Watson reported observation of the papilla of Vater with this instrument<sup>4</sup>. Finally, McCune succeeded in intubating the papilla and carrying out retrograde pancreatography with the aid of endoscopy<sup>5</sup>. Japanese gastroenterologists have been particularly involved in the development and initial clinical trials of the instruments now used for duodenoscopy. Of these gastroenterologists, Ashizawa, Hara, Kondo, Kozu, Oi, Shindo, Takagi, Takemoto, Tsuneoka, Yamagata and coworkers may be mentioned as representative. In Germany Demling examined the duodenum with endoscopic prototypes provided with straight-ahead viewing and with lateral viewing facilities in the year 1968.

For use in duodenoscopy we have today instruments with straight-ahead viewing and those with a lateral lens, both of which have their own indications.

### COMBINED ENDOSCOPIC EXAMINATION OF OESOPHAGUS, STOMACH, AND DUODENAL BULB

Instruments possessing straight-ahead viewing systems make it possible to carry out an endoscopic examination of the upper gastrointestinal tract with a single instrument and at a single sitting<sup>6,7,8,9</sup>. In principle, these instruments are nothing more than extended oesophagoscopes with a flexible tip.

### *Instruments*

FO 7089 A ACMI, EF long Olympus, Eder-Villa instrument.

### *Preparation of the patient*

One hour before examination the patient, who has been fasting for at least eight hours, is given 0.5 mg atropine subcutaneously and 20 mg trifluorpromazin, and just before the examination meperidine, 100 mg,<sup>6</sup> or diazepam<sup>15</sup> intravenously. Anaesthetizing the throat with oxybuprocain hydrochloride<sup>6</sup> or xylocaine<sup>10</sup> eases the introduction of the instrument through the pharynx

### *Examination technique*

After inspecting the oesophagus, the stomach is subjected to an initial orientating examination during which the walls are made just to 'unfold' by the passage of as little air as possible. This facilitates the passage of the instrument through the pylorus. If a closed pylorus cannot be passed after several attempts, the biopsy forceps can be used as a guide through the pylorus into the bulb and the instrument advanced in this way. In order to avoid perforations, the forceps must be retracted as the instrument is advanced. Excessive motor activity in the bulb is inhibited by the administration of 2 ml hyoscine-N-butylbromide<sup>6</sup>.

In our experience the bulb can be observed in its entirety as long as there is no marked scarring present. After bulboscopy, the stomach is thoroughly examined. If the inversion of the tip of the instrument for the inspection of the cardia and fundus cannot be effected successfully, this examination should be carried out subsequently with the aid of an instrument with a lateral lens. This is of particular importance when it is intended to perform selective biopsy in the upper portion of the stomach, since it is not always possible to pass the biopsy forceps through the strongly inverted tip of an instrument of the straight-ahead viewing type. In common with the majority of the Japanese authors, we are of the opinion that a thorough inspection of all the regions of the stomach is essential. The tip of the new mark 89A made by ACMI can be turned through almost 180° in the direction of the shaft.

### *Findings*

Up to the present time we have carried out 367 combined examinations of the oesophagus, stomach, and bulb (so-called upper panendoscopies) in our department<sup>11</sup>. With five exceptions, the cause of occult bleeding was determined with the aid of emergency endoscopy in 32 patients. Ekkers and his coworkers found the cause in 37 (74%) of 50 patients with haemorrhage from the upper gastrointestinal tract using the same procedure<sup>7</sup>. In 55 cases (14.9%) a positive finding was established despite a negative x-ray picture, and in 27 patients the radiograph or the suspected diagnosis was not confirmed. The discrepancy between the radiological and the endoscope findings involved the duodenal bulb in 56 cases (15.2%), the stomach in 22 cases (6.0%), and the oesophagus in four cases (1.1%)<sup>11</sup>. These figures indicate how justified this procedure is for all three organs examined, but particularly for the duodenal bulb, where, in addition to ulcers, scars, erosions, and polyps, a carcinoma was also found and biopsied.

Belber found in the duodenal bulb a polypoid tumour covered with gastric mucosa<sup>12</sup> and he, too, emphasized the importance of bulboscopy for the diagnosis of ulcers<sup>13</sup>. On the other hand, we are sceptical of his view that duodenitis can be diagnosed macroscopically<sup>14</sup>. After carrying out selective biopsies in 20 patients suffering from duodenal ulcers, Yamagishi and his coworkers<sup>15</sup> confirmed earlier results of our group which indicated that ulcers are usually not accompanied by inflammatory changes in the bulb<sup>16</sup>. In the near future, the problem of duodenitis as an entity will be resolved by endoscopic biopsy. Positive experience with bulboscopy, admittedly in part with instruments with lateral viewing, has been reported by Morrissey and his colleagues<sup>17</sup>, Kasugai<sup>18</sup>, and Sohma *et al*<sup>19</sup> also. Hara and Ogoshi invert the tip of the Olympus JF instrument within the duodenal bulb in order to find any ulcers immediately behind the pyloric ring<sup>20</sup>.

In addition to the diagnostic value of bulboscopy, this technique also has considerable importance for the evaluation of treatment.

#### EXAMINATION OF THE DUODENUM BEYOND THE BULB

The inspection of the entire duodenum and upper jejunum presupposes that the endoscope not only has sufficient length and good optical properties but also a short flexible tip that is capable of being turned in all four directions. These requirements are met in the two instruments we have available, namely, the JF Olympus and FDS Machida.

#### *Preparation of the patient*

Before the investigation Oi, Koza, Shindo, and others use a local anaesthetic for the pharynx, and in addition 20-60 mg hyoscine-n-butylbromide and 0.5 mg atropine<sup>21,22,23</sup>. We use a local anaesthetic for the pharynx and meperidine 100 mg intravenously before the investigation<sup>24</sup>. Takagi carries out the examination under general anaesthesia<sup>25</sup>.

#### *Examination technique*

The lateral-viewing instruments JF and FDS are advanced to a point immediately proximal to the pylorus under direct visual control, care being taken to ensure that as little air as possible is insufflated into the stomach. The instrument tip is then slid into the pyloric canal where visual control is momentarily lost. By advancing the instrument carefully, the duodenal bulb and the upper duodenal flexure can be passed. Pathological findings can be clarified with the aid of endoscopic biopsy. The size of the biopsy specimen obtained with the Machida forceps is adequate at  $0.7 \times 1.6$  mm. In 85% of biopsies all the mucosal layers are obtained<sup>10</sup>. The insertion technique described by Oi and his coworkers<sup>26</sup> has proved its worth in our experience. Not until after the intubation of the papilla of Vater, which is slightly below the superior duodenal flexure on the medio-posterior wall, is fluoroscopic control needed to ensure that the pancreatic duct is filled with the smallest possible amount of contrast medium. The pancreatic duct and the bile duct system are filled retrogradely with 60% urografin and shown radiologically<sup>11,21,23,25</sup>.

#### *Findings*

Oi and his colleagues describe three forms of the normal papilla: the hemispherical, the papillary, and the flat form which often alternate with one another during the examination<sup>27</sup>. A valvular protrusion in the orifice, which was first considered to be a septum between the pancreatic and bile ducts, can also be seen in the accessory papilla<sup>28</sup>. Oi *et al*, who have much experience in the field of duodenoscopy, were able to see the papilla of Vater in 98% of their examinations<sup>29</sup>. Takagi was able to insert the instrument into the duodenum in all 20 of the patients examined by him. On 13 occasions he saw the papilla of Vater and in nine cases was able to intubate it and demonstrate the bile duct system and/or the pancreatic duct<sup>30</sup>. Sohma and his colleagues saw the papilla of Vater in 86% of a total of 125 patients<sup>19</sup>. A similar rate is quoted by Kasugai and his colleagues (90.2% of 123 patients)<sup>31</sup>. Duodenoscopy, and in particular, the intubation of the papilla of Vater, requires practice and personal experience on the part of the examiner. In the last 20 duodenoscopic examinations we saw the papilla 19 times and were able to cannulate it 16 times<sup>11</sup>.

In addition to the pathological findings in the duodenal bulb, such as ulcers, erosions, polyps, diverticula, numerous lesions have been described beyond the bulb. At the 1970 European Congress of Endoscopy held in Munich, Oi showed representative pictures of the 35 carcinomas of duodenum, papilla, pancreas, and bile ducts he had diagnosed up to that time, in some of which the diagnosis had been established by endoscopic biopsy. In the case of carcinoma of the gallbladder and biliary system they observed that the papilla of Vater exuded a bloodstained secretion<sup>29</sup>. In our work we have seen three carcinomas of the papilla and one carcinoma of the duodenum<sup>11</sup>. Diverticula, polyps, and post-bulbar ulcers have now been described on a number of occasions<sup>18,23,29,32</sup>. The retrograde visualization of the pancreatic bile ducts by duodenoscopy has not only made possible the diagnosis of tumours but has also improved the differential diagnosis of obstructive jaundice<sup>19,29,30,32,34</sup>. Oi has shown in 18 cases that this is a method with little risk to the patient for differentiating between hepatic and extrahepatic obstructive jaundice<sup>29</sup>. In the case of choledochoduodenostomy, both parts of the common bile duct can be demonstrated with considerably more exactitude by directed intubation than by barium meal<sup>24</sup>.

### *Complications*

Following the instillation of contrast medium into the pancreatic duct, the serum amylase occasionally rises for one to two days without any clinical signs of pancreatitis<sup>21,30</sup>. To date, no serious complications of duodenoscopy have been reported.

### **Colonoscopy**

Colonoscopic examination after colotomy as proposed by Deddish and Fairweather<sup>35</sup> in 1953 was taken up by only a few surgeons<sup>36</sup>. Since the beginning of the 1960s various attempts have been made to find a method of examining the entire colon endoscopically.

#### EXAMINATION TECHNIQUES

##### *Colonoscopy with the aid of a transintestinal tube*

Transintestinal intubation for diagnostic purposes was described in 1955 by Blankenhorn *et al*<sup>37</sup>. In this procedure, the patient swallows a thin polyvinyl tube with a mercury bag at the end. When the tube has passed through the entire gastrointestinal tract, an instrument can be attached to its end and introduced into the colon by careful traction on the oral end of the tube. In this manner, biopsy instruments<sup>38,39</sup> and fibrescopes<sup>31</sup> can, with good prospects of success, be pulled up into the proximal sections of the colon. Provenzale and Revignas<sup>40</sup> have described a modification of this method (Fig. 1), using a pulley by which they were able to pass the left colonic flexure in more than 90% of 167 cases. A further modification of the method involves threading the transintestinal tube through the instrument channel of the colonoscope<sup>41</sup> or through a channel provided specially for this purpose<sup>42,43</sup>. The colonoscope is then introduced into the large intestine over the tube. The aim of this procedure is to keep the tip of the instrument in the central axis of the intestinal lumen and thus to avoid perforations. In 14 of 20 patients Paoluzi passed the instrument through the entire large intestine into the caecum in an average time of 28 minutes<sup>43</sup>. Hiratsuka maintains that he can introduce the instru-

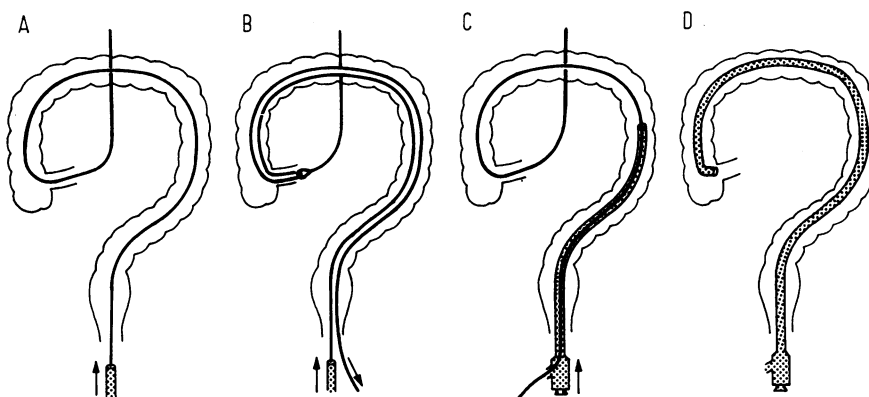


Fig. Methods of colonoscopy (modified after P. Deyhle and F. Paul).  
 A = transintestinal intubation (end-to-end)  
 B = pulley system  
 C = guide line or 'monorail' method  
 D = retrograde insertion of colonoscope without transintestinal intubation

ment into the caecum within 20 minutes.<sup>41</sup> The disadvantage of colonoscopy after transintestinal intubation is the time taken for the tube to pass through the intestine, which is usually between two and seven days<sup>41</sup>. If any obstruction of the gut is present, the technique cannot be used. Not infrequently, the tension on the tube causes discomfort from stretching of the mesentery<sup>31</sup>.

#### *Retrograde insertion of a guide tube*

In 1967 Fox and Kreel developed a 'colon tube' with a fixed angulated leading end<sup>45</sup>. By turning the tip and providing pressure from below, the instrument could be brought into the descending colon in 30% of cases and into the transverse colon in a further 10%<sup>46</sup>. After maximum introduction, the inner stilette is removed and replaced by a biopsy probe or a fibrescope. In 60 examinations, Fox and his coworkers had no complications. Ewe, too, reported good results in the inspection of the left side of the colon using a similar instrument<sup>47</sup>. All in all, the value of this instrument seems to be limited by the uncertainty as to whether higher regions of the intestine can be seen.

#### *Colonoscopy without preliminary intubation*

The recent reports of Deyhle, Watanabe, and Nagasako seem to indicate that the aids mentioned have become superfluous<sup>48,49,50</sup>. Modern colonoscopes can, with a high degree of success, be introduced through the entire large intestine.

#### INSTRUMENTS

If the term colonoscope is to be reserved for those instruments with which the entire large intestine can be inspected, the ACMI, FO 9000 A, the

Olympus CF-SB, and the FSS of Machida should, on account of their effective lengths, be designated as sigmoidoscopes. Using two of these shorter instruments, Overholt was able to advance to a distance of 70 cm in 66% of the cases he examined<sup>51</sup>. Dean and Shearman quote the average distance of insertion of the CF-SB into the colon as 30 cm (range 15 to 55 cm) compared with an average of 15 cm (range 11 to 25 cm) using rigid sigmoidoscopes<sup>52</sup>. Sakai and Ashizawa were able to pass the same endoscope through the sigmoid colon within five to 10 minutes in 84% of the patients examined<sup>53</sup>.

Two colonoscopes, the Olympus CF-LB, with an effective length of 180 cm, and the Machida FCS are now available. Watanabe and his coworkers used the Machida FCS in 25 patients; in 23 cases the instrument was advanced into the descending colon, in 22 cases into the transverse colon, in 10 into the ascending colon, and in eight into the caecum. It was emphasized that in seven of the last eight patients examined, the caecum was reached<sup>49</sup>. The importance of personal experience with this instrument was also underlined by Deyhle<sup>48</sup>. He was able to observe the upper sigmoid colon in all 28 of the patients he examined; in 25 cases (89%) he reached the transverse colon, in 23 patients the ascending colon, and in 22 patients (78%) the caecum<sup>48</sup>. Difficulties are presented by marked looping, especially prevalent in the regions of the sigmoid and the transverse colon, and pronounced kinking at the flexures.

#### PREPARATION OF THE PATIENTS

##### *Sigmoidoscopy*

Before sigmoidoscopy, Niwa and his coworkers recommend that no supper be given the day before and no breakfast on the day of the examination<sup>54</sup>. Further, they make use of castor oil and disposable enemas both on the evening before the examination and on the morning of the examination. Deyhle believes that two enemas are adequate, one the evening before and another on the morning of the examination. Any faecal residues in the intestine are then removed by the washing and aspiration which is possible with all the instruments<sup>48</sup>.

##### *Colonoscopy*

Greater difficulty is associated with the preparation of the patient for colonoscopy. The large intestine can be largely emptied by allowing the patient only liquid food for several days and by giving enemas just before the examination. In our department we arrange for a low-residue diet (Vivonex) over a period of three days before the examination and an enema the evening before and on the morning of the examination. With this procedure, we usually find that the large intestine is completely empty. Nagasako and his coworkers recommend that 25 ml of castor oil be administered orally on the evening before the examination<sup>50</sup>. Early on the morning of the examination day an enema of 500 ml of warm water is given and repeated one hour before the examination.

Deyhle does not believe that any drugs are needed. Nagasako gives 0.02 g hyoscine-N-butylbromide intramuscularly 20 minutes before the examination; Overholt prefers Diazepam; Fox uses barbiturates, pethidine, and propantheline bromide routinely, but, like other endoscopists mentioned, does not give a general anaesthetic.

## EXAMINATION TECHNIQUE

In this report the technique of retrograde insertion of endoscopes without transintestinal intubation will be described. The instrument is inserted with the patient in the left lateral or in the knee-elbow position. In these positions, the sigmoid colon can be passed. Subsequently, the patient is positioned on his back. During insertion, the operator should always try to look into the lumen of the intestine. In the sigmoid colon this is sometimes not possible. The instrument can, however, be cautiously advanced as long as the mucosa does not become white and anaemic in appearance<sup>48</sup>. Occasional fluoroscopic checks are to be recommended. If the sigmoid colon is markedly looped, the further passage of the instrument is difficult. In such a case, after passing the left colonic flexure, Deyhle strongly flexes the tip of the instrument and then 'hooks' it into the flexure. By pulling the instrument gently backwards, the sigmoid loop is then straightened out, the tip of the instrument remaining in place. The great advantage of this procedure is that the transmission of the pushing force to the tip of the instrument is considerably improved<sup>48</sup>. The passage of the instrument through the transverse colon can also be facilitated by drawing back the endoscope and straightening the sigmoid loop. In these cases, the instrument tip is 'hooked' into the right colonic flexure and the patient positioned on his side. Nagasako and his coworkers describe a similar method for the insertion of the colonoscope. They get round the difficulty of a 'tortuous' colon by fixing the tip of the instrument in the wall of the colon by strongly flexing the tip. Considerable dilatation is eliminated by aspiration of superfluous air. They consider it important that the position of the patient be changed in accordance with the course of the individual colon<sup>50</sup>. Proceeding in a similar manner, Watanabe *et al* were able to direct the colonoscope into the caecum in seven out of eight cases<sup>49</sup>. In their opinion this method is virtually optimal. When confronted with difficulties in the intubation of the colon, Overholt uses 'persuasive pressure' and rotates the instrument about its longitudinal axis in order to overcome them.

## FINDINGS

All the authors dealing with colonoscopy emphasize the value of this method in the differentiation of polyps and tumours, stenoses, diverticula, and inflammations<sup>40,42,46,52,55,56,57,58</sup>. After biopsy, Deyhle was able to identify a polyp in the caecum as a carcinoma and in four cases he found, after an apparently normal radiograph, benign polyps up to the size of a cherry<sup>48</sup>. In four out of 21 patients, Dean and Shearman found polyps in the large intestine although none had been found radiologically<sup>52</sup>. Matsunaga and Tayima demonstrated polyps in the colon in 13.1% of their patients using the fibre-colonoscopy, but only in 3.4% of their series examined with the conventional rectoscope. In 16 cases they found a total of 26 polyps, of which, after selective biopsy, five proved to be malignant<sup>57</sup>. Nagasako described the endoscopic picture of the early changes of 'backwash' ileitis, and of colitis involving the right side colon<sup>58</sup>.

The technique of fibre-colonoscopy has only just reached the stage of 'technical maturation'—which is not intended to imply that no further improvement in the instruments can be expected. It is certainly true, however, that already practised endoscopists are able to inspect the entire colon in 80 to 90% of their investigative series. With this figure they equal the results

achieved by the endoscopists who make use of the transintestinal intubation technique and its various modifications.

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