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Gastrointestinal Fiberscopy in dogs: A review

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Abstract
Endoscopy is one of the most diagnostically useful tools available in small animal medicine. The word Endoscopy is derived from the Greek word "Endo" meaning "inside" and "Skopeein" meaning "to see". Endoscopes are of two types rigid and flexible. Endoscopes and related equipment should be cleaned and decontaminated immediately after use, following manufacturers' written instructions**.** As compare to radiology and ultrasonography, endoscopy has a greater advantage for the physician to give a possibility to analyze tissue and moreover take a biopsy sample from the organ under investigation. It is curative in the case of digestive foreign bodies. Definitive diagnosis of chronic gastric pathology, gastric tumor or chronic intestinal disorders would have been impossible without the use of endoscopy. Apart from this diagnosis of gastric ulcers and hemorrhagic gastritis might be diagnose on the basic of clinical examination, but the characterization of lesions and it's extent could be properly diagnosed by endoscopy. Colorectal carcinoma needs also endoscopic examination for a definitive diagnosis. Endoscopes and their accessories should be cleaned and processed according to the manufacturers specific instructions.

Keywords: Clinical examination, colorectal carcinoma, endoscopy, foreign bodies

Introduction
Endoscopy has major technological advancements in the past decades, causing great impact on diagnostic accuracy [1]. Endoscopy is one of the most diagnostically useful tools available in small animal medicine. It affords the clinician a minimal invasive method to examine much of the gastrointestinal tract, upper and lower airway, post uterine and lower urinary tract, abdominal cavity, thoracic cavity and joint spaces [2]. Endoscopies are the essential tools**,** which allow us to see inside small spaces. The word Endoscopy is derived from the Greek word "Endo" meaning "inside" and "Skopeein" meaning "to see". It is a word used in medicine to describe the procedure used to see inside various part of the body. Historically, it was known that it is possible to insert tube into body orifices, but to see clearly a method was needed to illuminate the inside of the organ to be seen. 199 years ago in 1806 Philipp Bozzini published his invention of "Light guide" with this idea the basic of the modern Endoscopy was established [3].

The first effective open tube endoscope was developed in 1853 by Desormeaux for examine the urethra and the bladder. In the early 1900s, the first attempts to view inside the body with lighted telescopes were made. In 1930s, semi flexible Endoscopy called Gastro scope was developed to view inside of the stomach. Fiber-optic Endoscopy was pioneered by the South African born physician Basil Hirschowing at the University of Michiganin began in the 1960s. In 1986 with the introduction of video computer chip projection of image onto television screen become possible [4].

Principle
Fiber optic endoscopes are bundles of thin glass fiber to transmit light to and from the organ being viewed. These fibers use the principle of total internal reflection to transmit almost 100% of the light entering one end to another end. Fiber optic endoscopes are delicate and expensive items. The fibers have to be made of special glass, and each fiber has to be coated with a layer of glass of a different refractive index. In addition the orientation of fiber in a bundle used for endoscopy has been constant and not tangled up like the fibers in a rope. Each endoscope has one set of fiber bundles to transmit light inside and another set to transmit reflected light out to the eye of the viewer [5].

Endoscope System

[6] Describe the modern endoscope system which has at least three components –

1. The endoscope (Rigid and Flexible)
2. A light source
3. A light transmitting cable (which carrier light from the source to the endoscope)

With most flexible endoscopes, the light transmitting cable is permanently attached to the endoscope and has a section that plugs directly in to the light source. Numerous accessories and ancillary instruments may be added to the basic endoscope system. The equipment enhance functionality, diagnostic or therapeutic capability and communication.

Accessories can include various sheets and instruments for biopsy, grasping, aspiration, cytology, electro surgery and laser surgery; pumps for suction, insuflalation and irrigation, and attachable video camera for monitor viewing, videotaping, printing, and digital storage or transmission **[6]**.

Flexible Endoscopes

The two basic flexible endoscopes are the fiberscope and the video endoscope. The difference between the two relates to the system for sensing and transmitting images.

In a fiber optic endoscope the image is carried from the subject being examined to the eyepiece via bundles of optical glass fibers. In a true video endoscope the image is transmitted electronically to a video monitor from the distal tip of the endoscope where it is "sensed" by a charge coupled device (CCD) chip.

Fiber optic image can also be transmitted to video monitors and accessories by attaching a CCD camera to the eyepiece of the endoscope. Although fiber optic image quality cannot match that of the CCD sensor, the fiber optic systems have considerable cost advantage.

Feature	Fiber scope	Video scope
Image quality	Good	Excellent
Portability	Excellent	Poor
Cost	Moderate	High
Diameter available	Wide range	Smaller diameter not available
Video capability	Require CCD attachable camera	Integral

Flexible endoscopes are available in diameters ranging from 14 mm to less than 1 mm. Most, larger flexible scopes (greater than 2 mm in diameter) are equipped with an accessory channel and a deflectable tip.

Currently the most popular endoscope in small animal practice is the gastro scope, which has a four-way deflection tip. The tip's two-plane deflection capability (up, down, left and right) is crucial to the successful navigation of the gastrointestinal tract, particularly in the most challenging maneuvers through the pylorus and ileocolic orifice. Because most gastro scope have an outer diameter of 7.8 mm or greater, they cannot be used in smaller patients for such procedure as Broncoscopy, Rhinoscopy, and Urethroscopy. Consequently, the second most popular flexible endoscope in small animal practice is a smaller diameter fiberscope with limited tip deflection capability (one or two way) and a considerably smaller working channel [6].

Fiberscopes

The gastrointestinal fiberscope has three major sections:

- The insertion tube
- The hand piece
- The Umbilical Cord

Construction of the insertion tube is the most complex and technically challenging aspect of fiberscope design, because this portion of the instrument contains image guide (IG) and light guide (LG) fiber optic bundles, channels for suction, irrigation, and several layers of protective materials along the entire length of the tube. All of the components must be contained within an insertion tube that has the smaller possible diameters, largest possible accessory channel, and maximal tip deflection capabilities.

Flexible Endoscope

The last several centimeter of a fiber scope with tip deflection capability is called the bending section, controlled by the deflection (knobs) in the hand piece, this portion of the insertion tube may be deflected in one or two insertion tubes may be deflected in one or two plane. Deflection in a single plane (one way or two way angulated) is common in small diameter endoscope used for procedure such as bronchography and urethroscopy. But, endoscope designed for gastrointestinal use are equipped with four way angulations (up, down, left, right) which allows the endoscopist to deflect the tip in any direction by coordinating the simultaneous movement of the up/down and left/right control knob.

Two plane deflection capability is essential to a through endoscopic examination of the gastrointestinal tract. The degree of tip deflection varies among models, but complete retroflection (180º or greater) in at least one direction is desirable in a multipurpose endoscope. Many of the newer endoscopes are capable of 210º- tip deflection in at least one direction.

A close inspection of the distal tip of an insertion tube shows the cross – sectional location of several of the internal structures.

1. The insufflation channel allows room air to be blow in the gastrointestinal tract, distending the viscus and enabling examination of the mucosa.
2. The water jet exiting the irrigation channel is directed over the distal lens of the IG to remove debris and mucus when necessary.
3. The accessory channel is used for mucus suction and the passage of instrument such as biopsy forceps, grasping forceps, and cytology brushes.

a. The hand piece contains the eyepiece with its diopter adjustment ring, air/water and suction valves, deflection control knobs and locks, and the opening to the accessory channel.

b. The hand piece is designed to be held in the left hand. the index finger controls suction by fully depressing the first (tront) valve. The air/water valve can be controlled by the index middle finger. Insufflation is activated by placing the fingertip over the hole in the top of the valve. The thumb of the left hand is used to control the up/down deflection knob, insert channel accessories, and advances the insertion tube applying rotational forque when necessary, and care should be taken to ensure that deflection locks are in the unlocked position before deflection knob are used.

The umbilical cord contains the position of the fiberscope that connects to the light source. Including connectors for insufflation and irrigation in gastrointestinal scopes. It contains light carrying fiber bundles and therefore should be handled with caution. The light sources for gastrointestinal fiberscopes generally contain an internal air pump that

provides air for insufflation and air pressure for forcing water from an attached bottle through the irrigation channel. A pressure compensation valve in this region prevents damage from external pressure changes that may occur during ethylene oxide (ETO) sterilization or shipping by air [7].

Videoendosopes

The mechanical functions of a video endoscopy are similar to similar to those of a fiberscope. The primary difference lies in the way the image produced. Instead of a fiber optic image the video endoscope produces an electronic image that is sensed by CCD chip at the distal tip of the insertion tube just behind the objective lens. Higher image quality is the primary advantage of a video scope over fiberscope [8].

Light Sources

In 1960, Dr. Karl Storz discovers that a fiber optic light cable could transmit light from a remote light source through an endoscope to the examination site. The discovery heralded the birth of cold light endoscopy, which is the basic for the design of all modern endoscopic light sources. Although the light is not actually "cold", the technology represents a marked reduction in the incidence of thermal injury during endoscopic procedure [6].

Light transmitting cables

Although LGs are frequently built in the umbilical cord of flexible endoscopes, they are also available as separate detachable cable for use with some models and with rigid endoscopes.

The following is a list of the major types of endoscopy.

1. Gastroscopy: To see the gullet, stomach and upper small intestine.
2. Oesophagoscopy: To see the gullet, stomach and upper small intestine
3. Colonoscopy: To see the large intestine.
4. Cystoscopy: To see the urinary bladder.
5. Bronchoscopy: To see the air passages to the lungs.
6. Laryngoscopy: To see the larynx or voice box.
7. Nasopharyngoscopy: To see the nose and related cavities.
8. Laparoscopy: To see the "stomach cavity" and the organs therein.
9. Arthroscopy: To see inside joints such as the knee joint.
10. Thoracoscopy: To see inside the chest cavity.

There are number of other sub-types of "scopies" and these include proctoscopy, sigmoidoscopy, nephro-uretroscopy, mediastinoscopy, choledochoscopy, angioscopy and others.

Gastroduodenoscopy

Indications

Gastroduodenoscopy is principally used to biopsy the stomach and duodenum (and occasionally the proximal jejunum) in animals with signs that suggest gastrointestinal infiltrative, erosive or ulcerative disease (e.g., anorexia, vomiting, diarrhea, or weight loss) [9]. Gastroscopy valuable for diagnosis of intermittent vomiting [10] and Gastric cancer [11]. It is also valuable for removing foreign objects locating bleeding sites (especially before surgery) and recognizing gastric outflow obstruction arising from benign or malignant tumor [12]. Occasionally it reveals parasites, such as *Physaloptera* spp. and *Ollulanus tricuspis.* Unless contraindicated (e.g., coagulopathy), biopsies of the gastric and duodenal mucosa should always be obtained.

Equipment

Gastroduodenoscopes generally must have an insertion tube of at least 1 m working length, four-way deflection of the tip, a biopsy channel, an air-water channel, and suction capability. The outer working diameter of the scope is important and usually should be 9.4 mm or smaller. The smallest diameter scopes (i.e., pediatric models with a 7.9 mm or smaller outer diameter) are easier to pass into the duodenum, especially in cats, but have smaller biopsy channels (i.e. 2 to 2.2 mm), which are undesirable. With practice a 9 mm outer diameter scope with a 2.8-mm biopsy channel can routinely be passed into the duodenum of all but the smallest animals (i.e. those weighing 5 pounds or less). In our practice we routinely pass a 9.4 mm outer diameter scope into the duodenum of small dogs, and it usually can be used in cats weighing more than 7 pounds [13].

Patient preparation

The animal should be fasted for at least 24 hours, and dry foods should be avoided for at least 36 hours. Avoid parasympatholytic drugs, which slow gastric emptying, and barium sulfate, which obscures mucosal detail [13].

Anesthesia

Some opioid preanesthetics cause pyloric spasm and should be avoided. Ketamine, butorphanol, and acetylpromazine are excellent preanesthetic agents. Anesthesia is best maintained by inhalant agent [13].

Patient positioning

Typically, the patient is positioned in left lateral recumbency, although dorsal recumbency makes it easier to enter the antrum. Avoid extensively repositioning the patient during the procedure while the endoscope is in the stomach, or gastric volvulus may occur [13].

Examination of gastroduodenal region

[14, 13] Suggest that after attaining an adequate plane of anesthesia, pass the scope through a protective mouth gag to the level of the larynx. Always look through the scope as it is advanced. Be cognizant of the amount of air insufflated; air insufflated into the oesophagus can pass into and fill the stomach. Keep the center of the esophageal lumen in the center of the scope's viewing field and insufflate sufficient air to distend the oesophagus as the tip of the scope is advanced through the cricopharyngeal sphincter and down the oesophagus.

Normal esophageal mucosa is pale and smooth except just caudal to the cricopharyngeal sphincter, where it may be slightly roughened. Submucosal blood vessels are typically seen, especially near the lower esophageal sphincter [15]. The distal feline esophageal mucosa has many small folds, which correspond to the site of the herringbone pattern seen on barium esophagrams. Do not over insufflate; an excessively distended stomach puts pressure on the diaphragm, making it difficult for the patient to breath. If gastric distention is dramatic, cardiac output may decline. Also, the distance the tip of the endoscope must travel along the greater curvature as it approaches the pylorus increases as the stomach is distended, and with excessive distention the scope may become too short to enter the pylorus. The lower esophageal sphincter often appears as a slit, although it may be open. Do not attempt to push the scope blindly through this sphincter if it is closed. Aim the tip toward the slit and carefully advance it.

After entering the stomach, a red blur (i.e. red out) may be seen if the stomach is not already distended with air. Distend and examine the stomach of animals weighing less than 40 pounds before passing the scope into the duodenum. In larger dogs it may be desirable to pass the scope into the duodenum first, before distending the stomach with air (this is not usually a concern if a scope with a working distance longer than 1.4 m is used). When the scope first enter the stomach, little or no detail is seen if the stomach is deflated. In sufflate the stomach until the surface of gastric mucosa can be inspected. Ulcer, growth and parasite hidden between the mucosal folds in an undistended stomach are easily over look.

Foreign body removal

Gastrointestinal foreign bodies are relatively common in canine and feline **[16].** Due to their slightly indiscriminate eating habits, swallowing of incompletely masticated food and exposure to toys and dental chews, dogs are more likely to be presented with gastrointestinal FBs than cats.

For the removal of the foreign body, snare the object and draw it up next to tip of the endoscope. If the object is still difficult to pull in the oesophagus, pass the flexible endoscope through a larger diameter rigid endoscope or rubber tube (over tube). Grab the foreign object and again pull it up to the tip of the endoscope. Carefully pass the over tube down the flexible scope until the over tube enter in the stomach.

Then carefully draw the flexible scope (with the foreign object as close to the tip as possible) as far into the over tube as possible so that the object is up against the end of the over tube. In this manner, the larger diameter over tube further dilates the lower esophageal sphincter and makes it easier for the object to pass through the sphincter. Remove the scope, over tube, and foreign object as a unit. This technique is also useful for pulling objects through the cricopharyngeal sphincter and for removing objects with sharp edges such as glass, razor blades, and safety pins **[17].**

When removing linear foreign objects that are trailing off into the duodenum, try to pass the tip of the endoscope through the pylorus and down the duodenum so that the distal end of the linear object can be grasped. That end is then pulled into the stomach, which makes it easy to remove the entire object. If the foreign object is relatively thick (e.g., cloth or cotton) rather than thin (e.g., twine, string, or narrow strips of cloth), the endoscopist can try to pull it into the stomach by grasping it near the pylorus; However, this approach risks rupturing the duodenum, especially if the foreign object has been present for 2 days or more. If the orad portion of a linear foreign object is lodged in the stomach because it cannot pass through the pylorus, it occasionally is possible to use the endoscope to push this part into the duodenum, allowing the entire object to pass through the intestines [13].

Oesophagoscopy

Indications

Automatically oesophagoscopy is done any time when the gastroduodenoscopy is performed. Oesophagoscopy is often performed after radiographic assessment for evaluate animals suspected of oesophageal stricture, Oesophagitis, Intraluminal mass, Reflexesophagitis **[18],** Foreign body [19].

Occasionally it is needed to biopsy suspected neoplasms or to look for *Spirocerca lupi* infestation, hiatal hernias, or other causes of esophageal disease in regurgitating pets. It is seldom useful for evaluating esophageal motility problems caused by muscular weakness. The oesophageal mucosa is not routinely biopsied unless a mass or an obvious infiltrative lesion is seen [20].

Equipment

Gastroduodenoscopes are superior to rigid equipment for evaluating the mucosa, whereas rigid scopes are preferred for removing foreign objects. Rigid scopes allow the use of rigid retrieval forceps, which gain a firmer hold on objects. However, rigid colonoscopes are seldom long enough to retrieve foreign objects in dogs weighing more than 25 to 30 pounds; in such cases a flexible scope often must be used.

Patient Preparation

No special preparation is needed. There is seldom any need for contrast radiographs to diagnose esophageal foreign bodies, and a barium contrast esophagram can make the procedure more difficult.

Anesthesia

Inhalant anesthesia is preferred to maintain a patent airway, especially when removing large foreign objects that may put pressure on the trachea. Careful monitoring is needed when using a rigid scope, because the scope can easily exert too much pressure on the heart, great vessels, and airways.

Patient Positioning

Lateral recumbency usually is adequate. When using rigid equipment, it is important that the oesophagus be kept as straight as possible.

Examination of oesophagus

The technique for flexible oesophagoscopy (the preferred technique when looking for oesophagitis or strictures) is described under gastroduodenoscopy. Oesophagitis is denoted by erythematous, bleeding, and/or ulcerated areas. Gastrointestinal bleeding is a common cause of hospitalization and results in extensive use of health care resources. By the most conservative measures, the cost of inpatient care alone for GI bleeding in the United States exceeds $6.5 billion each year [21]. Strictures often are obvious in smaller animals but may be subtle in larger patients. Benign strictures often are smooth, whereas malignant strictures usually appear rough. Obvious tumors occasionally are noted. Most tumors can be biopsied adequately with flexible forceps.

Removal of Foreign Bodies

Ingestion of foreign body is a relatively common occurrence worldwide, which may lead to morbidity and mortality of the dogs. With the advancement of endoscopic technique, the majority of ingested foreign bodies in the upper GI tract are best treated with flexible endoscopes, with a high successful removal rate of >95%. **[22].** Pneumothorax or pleural effusion in animals with esophageal foreign bodies strongly suggests perforation; thoracotomy should be considered in such patients, although small perforations sometimes heal spontaneously after the object is removed.

Patient is positioned to make the oesophagus as straight as possible (i.e. simultaneously push the base of the skull ventrally and pull the nose dorsally) to avoid putting pressure on the trachea at the thoracic inlet or on the great vessels at the base of the heart. Advance the scope slowly while visualizing the lumen. Avoid putting pressure on the foreign object (Dog's oesophagus with a chicken bone lodged in the lumen), stricture, or blind sac so as not to rupture the oesophagus; a perforation may be present even if it is not

obvious from the endoscopic appearance. Be extremely careful when insufflating air into patients with foreign objects; you may cause tension pneumothorax with even a minute perforation. A rigid grasping forceps (not biopsy forceps) is used to manipulate the object into the scope so that the mucosa is protected as the object is withdrawn from the oesophagus. If the object is tightly wedged in the lumen, excessive force should not be used or the oesophagus may rupture. The object should be repositioned until it can be at least partly pulled into the endoscope. If the foreign object cannot be withdrawn or repositioned, it sometimes can be broken into smaller pieces with the rigid retrieval forceps. This must be done very carefully; the end of the rigid scope is positioned against the object so that when the operator pulls against the object with the forceps, the pressure is applied to the distal end of the scope and not the wall of the oesophagus. Bites are taken from the object (usually a bone) until it is smaller and can be manipulated as desired (Simpson).

After removal of the object, some degree of esophageal ulceration often is seen. Gastroesophageal reflux may occur secondary secondary to this condition if the inflammation is severe enough.Antacids (e.g., ranitidine, 2.2 mg/kg IV given twice a day or famotidine, 0.5 mg/kg IV given once or twice a day) may help because gastroesophageal reflux is common, either as the primary event or secondary to the esophagitis. However, severe esophagitis often requires use of proton pump inhibitors (omeprazole, 0.7 to 1.5 mg/kg given once or twice a day). If the ulceration is severe; a gastrostomy tube guarantees administration of nutrition as well as drugs. Antibiotics effectiveagainst anaerobic bacteria from the oral cavity (e.g., amoxicillin, 22 mg/kg SQ given twice a day) and carafate slurries sometimes are used, but there is little documentation of their efficacy. Most esophagitis lesions and esophageal ulcers heal in 7 to 14 days. The chest is radiographed immediately after removal of the foreign object to check for pneumothorax. Fishhooks embedded in the oesophagus usually can be removed endoscopically. Small-diameter hooks and those with small barbs usually can be forcefully pulled through the mucosa, whereas large-diameter hooks may require surgical assistance. Surgery is safer if the point of the hook and its barb has completely perforated the oesophagus and is positioned such that the barb may lacerate vital structures (e.g. the great vessels of the heart) when pulled back into the oesophagus.

If the hook is oriented with its point directed caudally, firmly grasp the bend in the hook with the retrieval forceps, place the edge of the rigid scope very near the point of the hook's entry into the mucosa, and forcefully pull it cranially, tearing the barb through the oesophagus. If the point is oriented cranially, grasp the eye of the hook firmly with a retrieval forceps that has been passed through the scope and advance the rigid endoscope until it comes in contact with the bend of the hook. Then push the scope and forceps caudally as a unit, tearing the barb out of the esophageal mucosa. Reposition the hook with the point withdrawn into the scope and withdraw the scope and hook. The hole created by tearing the hook out of the oesophagus usually heals without incident unless it becomes infected. Antibiotics are indicated, especially for anaerobic bacteria, which may be present from the bait on the hook. If the hook is too large in diameter or the barb is too large so that the hook cannot be torn out endoscopically.

Care of Endoscope

Endoscopes and related equipment should be cleaned and decontaminated immediately after use, following manufacturers' written instructions. Endoscopes and their accessories should be cleaned and processed according to the manufacturers' specific instructions. Flexible endoscopes, by virtue of the body cavities in which they are used, acquire high levels of microbial contamination during each use [23]. More health care associated infection outbreaks have been associated with contaminated endoscopes than with any other medical device [24]. Use of proper protocols reduces the risk for adverse patient outcomes, prevents damage to the lenses and fiber-optic components of the instruments, and helps prevent delays by avoiding unnecessary malfunction.

Endoscopes, endoscopic accessories, and related equipment should be disassembled and cleaned manually, using mechanical friction when possible. Endoscopes and related equipment are considered contaminated after use. Immediate cleaning reduces the formation of thick masses of cells and extracellular materials known as biofilms [25]. Biofilms are microbial masses that attach to surfaces that are immersed in liquids. After they have formed, sterilizing/disinfecting agents must penetrate the agent-resisting biofilms before killing microorganisms within the biofilms. Immediate decontamination is necessary to protect patients and personnel and to prevent transmission of potentially infectious microorganisms. Flexible endoscopes that have crevices, joints, and internal channels may be more difficult to clean and sterilize or disinfect than rigid instruments that have flat surfaces. Removing gross soil from narrow internal channels and lumens may be difficult.

Advantages and disadvantage of endoscopy: The following advantage and disadvantages of endoscopy.

Advantages

- Minimal patient stress or mortality.
- Can be performed more quickly than abdominal surgery.
- Usually diagnostic for infiltrative disorders of the duodenum and stomach.
- Better than surgery for finding mucosal lesions such as ulcers.
- Most sensitive means of detecting erosions and ulcers.
- Useful for detecting gastric outflow obstruction.
- Can detect gastric parasites that are otherwise difficult to find.

Disadvantages

- Cannot examine entire intestinal tract; lesion may be beyond reach of scope.
- Biopsies usually adequate but not as good as full thick-ness.
- Samples obtained surgically, especially for sub-mucosal and sub-serosal lesions.
- Requires expensive, flexible equipment.
- Cannot determine if an ulcer is going to rupture or bleed severely just by observing it.

Conclusion

As compare to radiology and ultrasonography, endoscopy has a greater advantage for the physician to give a possibility to analyze tissue and moreover take a biopsy sample from the organ under investigation. It is curative in the case of digestive foreign bodies. Definitive diagnosis of chronic gastric pathology, gastric tumor or chronic intestinal disorders would have been impossible without the use of endoscopy. Apart from this diagnosis of gastric ulcers and hemorrhagic gastritis might be diagnose on the basic of clinical

examination, but the characterization of lesions and it's extent could be properly diagnosed by endoscopy. Colorectal carcinoma needs also endoscopic examination for a definitive diagnosis.

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