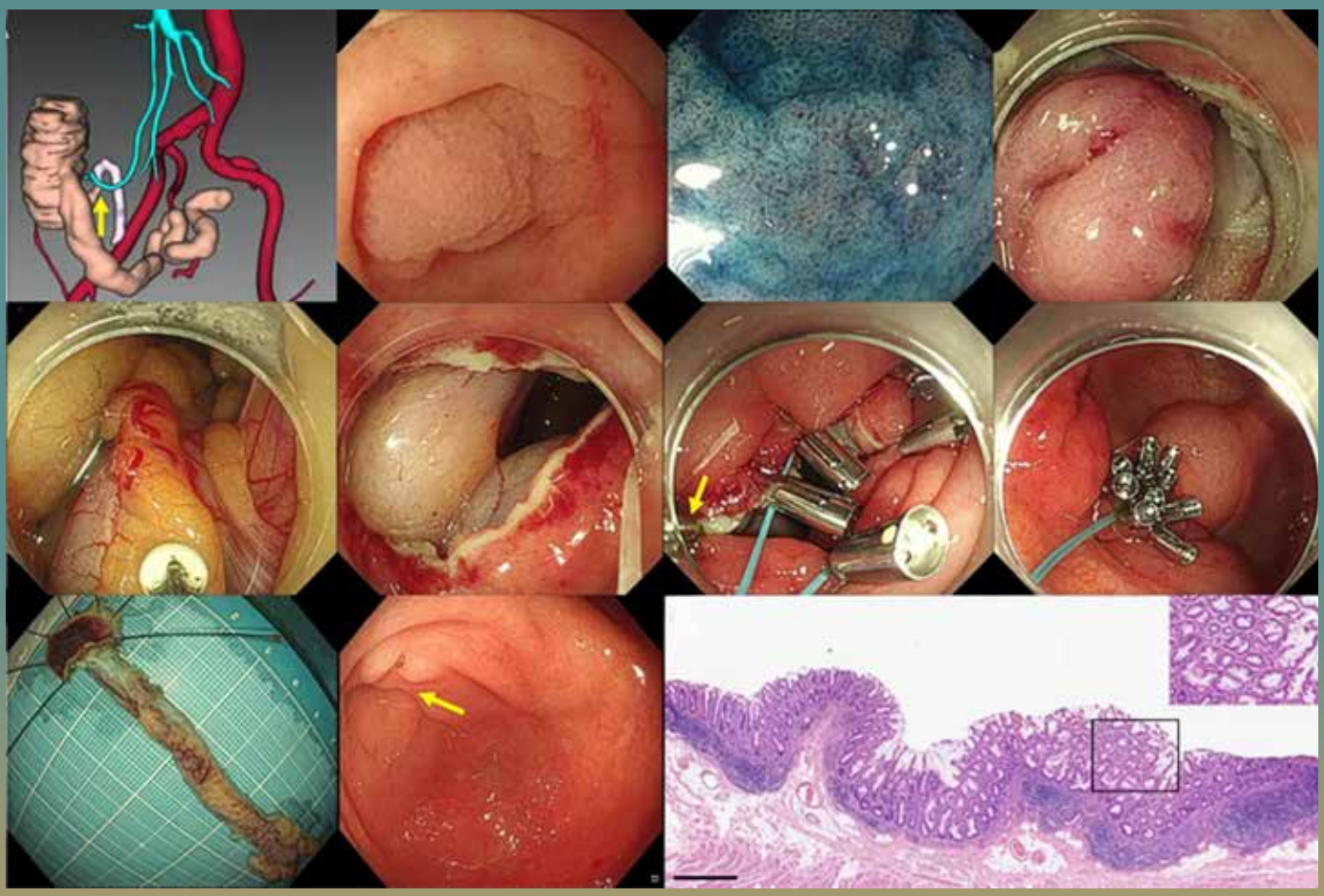


Endoscopic Transcecal Appendectomy

Part 3

Kevin B. Frey, CST

TECHNIQUES FOR CLOSING THE APPENDICEAL STUMP

One of the most critical steps of an appendectomy is closing the appendiceal stump to prevent a postoperative intra-abdominal infection resulting from fecal matter leaking into the abdominal cavity. Various closure devices for use during an endoscopic appendectomy have been developed including endoclips, endoloops, and staplers. The advantage of one over another has not been definitively established and is based upon surgeon's preference. What does matter is cost. For example, endoclips tend to be less expensive than the other methods of closure.

Endoclips are available in biodegradable or metallic form. The two main advantages of endoclips are the ease of loading them onto the laparoscopic clip applier by the Certified Surgical Technologist (CST™) and the ease of application by the surgeon leading to reduced operative time. The main disadvantage of endoclips is limited width. Endoclips have been applied to appendiceal base diameters that are up to 16 mm, but their effectiveness decreases for diameters that are 1 cm or more causing concern for fecal leakage.[1,2] Endoclips are much less expensive compared to other closure methods, which lowers the cost of the procedure for the patient as well as overall healthcare costs.

Endoloops are detachable snares that facilitate ligating pedicles during laparoscopic procedures, particularly during a laparoscopic appendectomy. The device typically consists of an 18-inch-long ligature within a plastic tube that is narrow at one end and scored at the other, where it is attached. The suture is formed in a ligature loop with a knot. The surgeon places

LEARNING OBJECTIVES

- Describe the various techniques for closing the appendiceal stump
- Discuss the advantages of the endoscopic transcecal appendectomy procedure
- Examine the disadvantages of the endoscopic transcecal appendectomy procedure
- List the equipment and instrumentation necessary for performing an endoscopic transcecal appendectomy
- Recognize the steps of the endoscopic transcecal appendectomy procedure
- Identify the postoperative complications that can occur

KEYWORDS

adverse events, appendiceal orifice, cecectomy, endoclips, endoloops, endoscopic full-thickness resection, endoscopy mucosal resection, endoscopic transcecal appendectomy, intra-abdominal abscess, hemicolectomy

DEFINITIONS

Colonic sessile serrated lesion: Pale or reddish colored lesions that are flat or slightly elevated (sessile) with a saw-toothed (serrated) appearance. The lesions are precancerous polyps, usually occurring in the cecum and ascending colon.

the ligature over the appendix and positions it at the base (Figure 1A). Once in place, the scored end is snapped and pulled upward to tighten the loop and secure the knot. The surgeon may place two endoloops, however, research has shown there may be no significant difference in surgical outcomes when using one endoloop versus two endoloops (Figure 1B).[3]

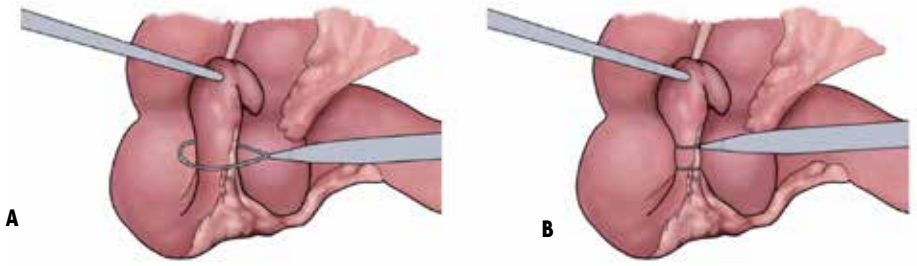


Figure 1 *Application of endoloops around base of appendix.*

Endoloops provide a low-cost option for safely securing the appendiceal base with excellent patient outcomes.[3,4] The use of one endoloop provides additional cost savings for the patient and healthcare systems across the US considering the large number of appendectomies that are annually performed.

Staples, upon firing, form a closed staple line by simultaneously clamping and incising the tissue. Staples have multiple advantages including ease of loading and firing. In an appendectomy, the use of staples is particularly useful in instances of acute inflammation that can be responsible for expanding the base of the appendix.[5,6] The drawback of staples is the high cost, with a single endoscopic staple line costing approximately $770.[7]

ENDOSCOPIC TRANSCECAL APPENDECTOMY

Discussion

With an emphasis upon and increase of colon cancer screening for individuals who are 45 years of age or older, the discovery of appendiceal and cecal lesions has increased.[8] Right hemicolectomy and partial cecectomy have been the standard procedures for removing the lesions. Right hemicolectomy, however, has a history of a high rate of postoperative complications and can be considered an unnecessary procedure for the excision of relatively benign lesions such as adenomas, low grade appendiceal mucinous neoplasms and serrated lesions.[8] Partial cecectomy is less invasive as compared to right hemicolectomy, but the procedure does not present the surgeon with the ability to fully visualize the lesion margins. Extended resections, such as right hemicolectomy, may be performed in certain cases when the surgeon needs to ensure negative margins have been attained.

Endoscopic transcecal appendectomy (ETA) procedure has been performed to remove the appendix for various reasons including appendicitis, appendiceal retention cysts, appendiceal polyps, and colonic sessile serrated lesions. The ETA procedure was introduced in 2018 when Bing-Rong Liu, MD, published the first description of the procedure.[9] The procedure involved a 53-year-old man who presented with a cecal polyp located by the appendiceal orifice. Upon removal of the appendix, the pathological diagnosis was appendiceal retention cyst. The patient fully recovered and was discharged from the hospital three days postoperatively.[9]

Compared with open procedures, ETA has multiple advantages. The surgeon can directly visualize the inflamed appendix or if there is an associated appendiceal orifice lesion.[8] This provides the surgeon with the ability to preserve the ileocecal valve and intestine. Because

the surgeon can visualize the appendix so well, it provides more direct access to the appendiceal orifice lesion, if present, and the appendix itself, which can decrease injuries to adjacent tissues, particularly in patients who have a history of abdominal surgery. Another potential advantage of ETA is that it provides the surgeon with a more accurate resection range.[10] Another benefit of ETA is that the procedure does not leave scars on the patient's abdomen, thus eliminating postoperative complications such as incisional hernia and wound infection. Lastly, when the surgery is required due to the discovery of an appendiceal lesion, ETA provides for complete resection of the lesion and the appendix simultaneously.[11]

> "One of the most critical steps of an appendectomy is closing the appendiceal stump to prevent a postoperative intra-abdominal infection resulting from fecal matter leaking into the abdominal cavity."

Surgical Technique Insights

There are several technical aspects of ETA to be considered. As with any appendectomy, whether an open procedure or performed endoscopically, identifying the anatomical position of the appendiceal artery within the mesoappendix is important to prevent hemorrhage. The variable location of the appendiceal artery suggests that the mesoappendix must be carefully resected to sufficiently expose the artery to achieve hemostasis. This is particularly important during an endoscopic procedure to prevent converting to an open procedure. A challenge, however, can be resecting fat tissue in the mesoappendix because of the higher electrical resistance in fat.[8] Another challenge to the ETA procedure is the presence of distal intestinal looping that can hamper the ability of the surgeon to manipulate the endoscope.[8]

When performing ETA for removing a lesion that may be pre-cancerous or cancerous, the surgeon must avoid rupturing the lesion that can cause tumor seeding within the abdomen (see Box 1 that refers back to the discussion of the ETA procedure that was first performed by Dr. Liu). The lesion must be kept intact when removing the appendix. This is achieved by circumferential full-thickness resection around the lesion as well as gently bringing it forward into the colon with the use of a snare.[11] It is recommended that ETA should not be performed for appendiceal orifice lesions with deep tissue infiltration that have a clear possibility of being malignant.[8,11] ETA does not provide the ability to completely resect lesions that originate deep within the appendiceal orifice.[8] Therefore, preoperative evaluation by computed tomography, endoscopy, or endoscopic ultrasound are essential to rule out lesions that may be highly malignant and deeply infiltrated.

PSEUDOMYXOMA PERITONEI

Retention cyst is a sub-type of appendiceal mucocele that is typically benign. It appears as a balloon-shaped mucosal bulge protruding from the appendiceal orifice that is characterized by the inner accumulation of mucus. To remove the cyst an appendectomy is the common surgical procedure. It is important, however, to ensure the cyst is not ruptured during the procedure and is removed intact with the appendix. Rupture of the cyst releases the mucus into the peritoneal cavity, allowing the sticky fluid to spread and possibly cause pseudomyxoma peritonei (PMP), a rare type of cancer. Cancer cells develop that produce mucin, the jelly-like substance that is one of the components of mucus, that can eventually overwhelm the peritoneal cavity affecting the digestive system. The name of the disease means "false mucinous tumor of the peritoneum" because the cancer does not form a well-define tumor.

Procedural Steps

The following is a list of the endoscopic instrumentation and supplies that will be required during the procedure.

- Endoloop
- Endoclips
- Dual knife
- Hook knife
- Endoclip applier
- Straight 4-mm clear cap
- Insulated-tip knife (IT knife)
- Single and double channel endoscopes[10]

The patient will either be intubated or non-intubated for delivery of general anesthesia depending on the decision of the anesthesia provider and surgeon. The most used patient position is left lateral, however, in some instances the patient may be placed in the prone position. The following are the procedural steps.[9-12]

Figure 2
Three-dimensional reconstruction images showing the appendix (yellow arrow) and adjacent bowel and vessels.

1. After carbon dioxide insufflation of the abdomen is achieved, intestinal cleaning is completed. A 4-mm clear cap is attached to the tip of the endoscope. The terminal ileum, ascending colon, and cecum are irrigated several times with body temperature sterile water to thoroughly clean the operative site (Figure 2).
2. A dual knife is used to make a circumferential marking of the lesion border.
3. The dual knife, hook knife, or IT knife are used to make a full-thickness incision around the appendiceal orifice and lesion (Figure 3).

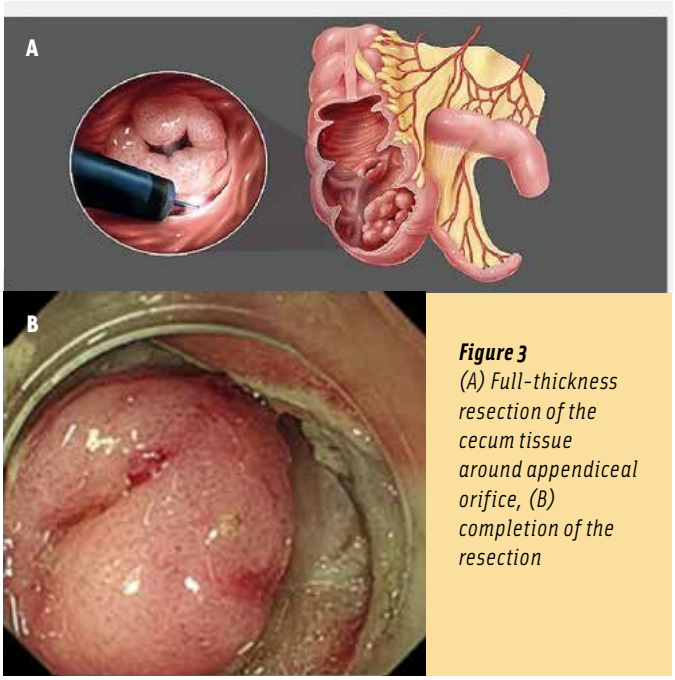


Figure 3
(A) Full-thickness resection of the cecum tissue around appendiceal orifice, (B) completion of the resection

4. The endoscope is inserted into the peritoneal cavity through the incision (Figure 4A).
5. Circumferential dissection is completed along the border of the appendix.
6. Using a dual knife or IT knife, the surgeon dissects the mesoappendix from the border of the appendix, in addition to cauterizing the appendicular artery. Snare traction is used to assist with the dissection (Figure 4B).

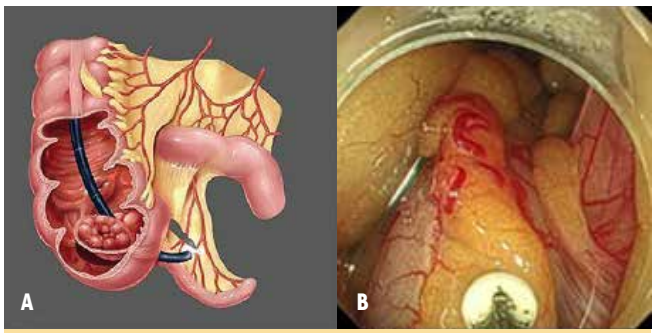


Figure 4 *(A) Introduction of the endoscope into the peritoneal cavity through the incision to dissect the mesoappendix, (B) endoscopic dissection of the mesoappendix along the appendix by an IT knife.*

7. The appendix is pulled into the colon with the use of the snare and removed through the anus with the continued use of the snare (Figure 5).

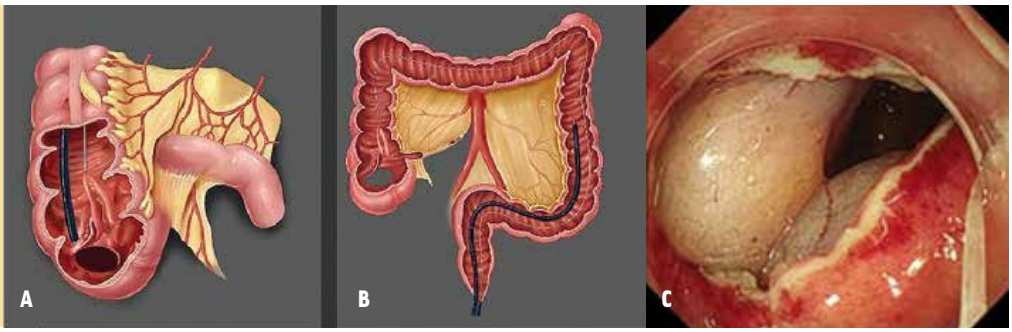
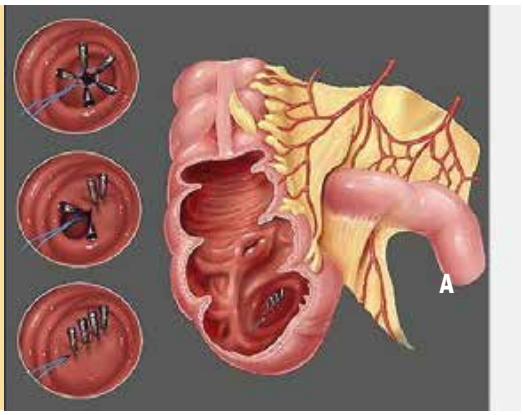
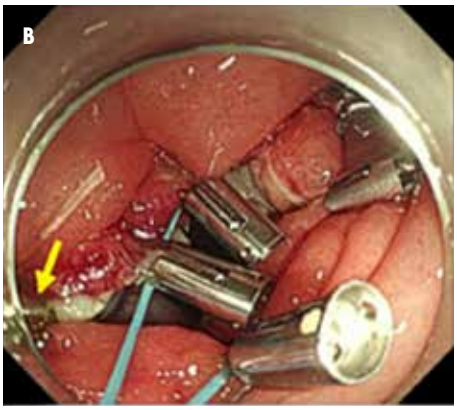


Figure 5 *(A) Snare-assisted traction of the partially dissected appendix for adequate exposure of the cutting line, (B) a second endoscope was inserted for continuous dissection, (C) the cecal defect.*

8. The single channel endoscope is replaced with a double-channel endoscope that allows the simultaneous insertion of the endoclip applier and endoloop. The cecal defect is doubly closed with endoclips and endoloops. The endoloop is placed around the cecal defect and the endoclips are applied over the loop at several positions. Upon tightening of the endoloop, the edges of the defect are approximated, and the closure is completed (Figure 6).

"Compared with open procedures, ETA has multiple advantages."





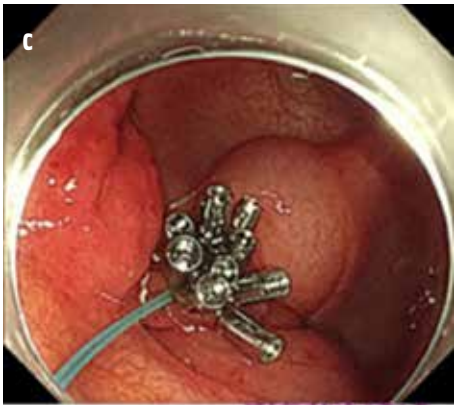


Figure 6 *(A) Closure of the defect using double endoscopic suture technique, (B) an intraprocedural endoscopic image showing clips and endoloop used for closing the cecal defect (yellow arrow), (C) the cecal defect closed by clips and endoloop.*

9. Depending on surgeon's preference, a drainage catheter may be inserted.

Total procedure time varies according to the surgeon's experience and slight variations in surgical technique; however, the procedural duration is typically about 60 minutes.[13]

Postoperative Care and Possible Complications

Postoperatively, the pathologist will perform a detailed evaluation of the resected lesion and appendix that will assist with forming the postoperative plan for treating the patient that underwent ETA (Figure 7). The patient's hospital stay can vary from three to eight days. The patient may have to fast for two to three days postoperatively. The patient also receives intravenous antibiotics for a minimum of three days.[11]

"Endoloops provide a low-cost option for safely securing the appendiceal base with excellent patient outcomes."

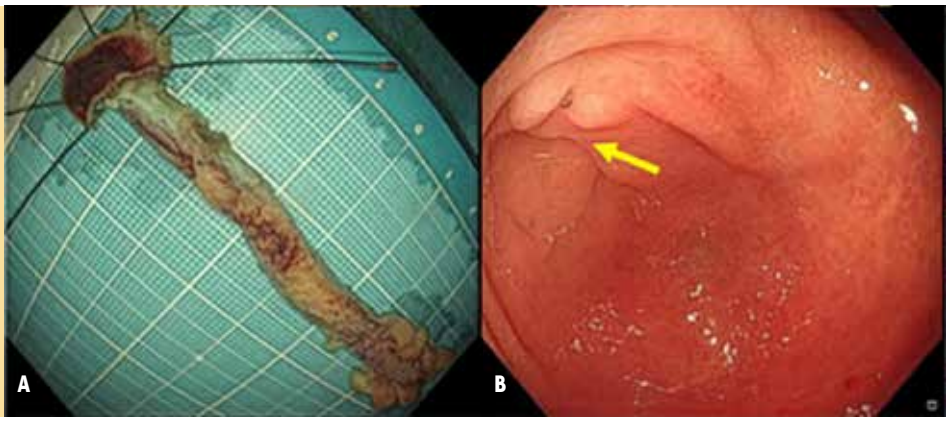


Figure 7 *(A) Specimen, (B) Endoscopic follow-up image showing the cecum 3 months after discharge (yellow arrow: the wound healing scar).*

Postoperative adverse events that can occur include hemorrhaging, intra-abdominal abscess (IAA), and cecal perforation.[11] If a patient displays signs and symptoms of hemorrhaging an emergency endoscopy is performed to confirm the diagnosis. An IAA is considered an abscess inside the abdominal cavity that is confirmed by either ultrasound or computed tomography scan.[11]

Links to Videos of Procedure

pmc.ncbi.nlm.nih.gov/articles/PMC9132730

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Endoscopic Transcecal Appendectomy, Part 3

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1. **Which of the following is a postoperative complication?**
   a. Cecal perforation
   b. Bowel obstruction
   c. Incisional hernia
   d. Ileus

2. **Which of the following presents a challenge to resecting the mesoappendix?**
   a. Ileocecal valve injury
   b. Visualizing the artery
   c. Presence of fat tissue
   d. Appendix is retrocecal

3. **What is used to bring the appendix within the colon?**
   a. Babcock forceps
   b. Retrieval basket
   c. Hook
   d. Snare

4. **Which of the following is a disadvantage of endoclips?**
   a. High cost
   b. Limited width
   c. Difficult to apply
   d. Increased operative time

5. **Which of the following is a type of cancer that can occur when mucus from a ruptured cysts enters the peritoneal cavity?**
   a. Pseudomyxoma peritonei
   b. Colloid carcinoma
   c. Squamous cell carcinoma
   d. Leiomyosarcoma

6. **Which technique is best for closing the appendiceal stump in instances of acute inflammation?**
   a. Staples
   b. Endoclips
   c. Endoloops
   d. Electrocautery

7. **Which patient position is commonly used to perform endoscopic transcecal appendectomy?**
   a. Prone
   b. Supine
   c. Left lateral
   d. Lithotomy

8. **Which of the following is a true statement regarding partial cecectomy?**
   a. More invasive than right hemicolectomy
   b. Extended history of postoperative complications
   c. Procedure of preference for excising adenomas
   d. Inability to fully visualize the lesion margins

9. **Which of the following is a false statement regarding endoscopic transcecal appendectomy?**
   a. Surgeon can preserve the ileocecal valve
   b. Difficult for surgeon to visualize the appendix
   c. Provides surgeon a more accurate resection
   d. Less chance of injuring adjacent tissues

10. **ETA is the preferred procedure for removing appendiceal lesions that originate deep in the tissue.**
    a. True
    b. False

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