

A new device to simplify flexible endoscopic treatment of Zenker's diverticulum

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Background: Endoscopic treatment of a Zenker's diverticulum (ZD) is challenged by maintaining a stable position and visual field. An oblique transparent cap and an overtube have been used with success. The porcine hypopharyngeal pouch is similar to a ZD. While using the widespread EMR device (WEMR) in the esophagus, we realized that the design may be advantageous for treatment of a ZD.

Objective: To use the WEMR cap device to incise the porcine hypopharyngeal pouch septum.

Design: WEMR cap incision of the porcine hypopharyngeal pouch septum.

Settings: Animal laboratory.

Interventions/Methods: Six female domestic pigs underwent endoscopy with the prototype WEMR cap. The cutting wire incised the hypopharyngeal-esophageal septum. Three pigs were immediately euthanized and underwent neck dissection. Three pigs were kept alive for 3 weeks and then underwent excisional neck dissection.

Results: The procedure was technically easy. The average time was 10 minutes. Limited bleeding occurred by using cutting current and was eliminated by blended current. The entire septum could be incised with the cap edges working as a stopper, until the septum almost completely disappeared. No overt complications occurred. A follow-up endoscopy showed a small residual septum and scar. A barium swallow revealed no pouch, with ready passage into the esophageal lumen.

Conclusions: The WEMR wire-cutting cap can incise the hypopharyngeal septum in an animal model simulating ZD. This device has the advantage of providing a stable position throughout the procedure and a protective rim that controls the incision. The device facilitates this procedure. (*Gastrointest Endosc* 2008;67:112-5.)

The endoscopic approach to the treatment of a Zenker's diverticulum (ZD) could be the preferred technique in high-risk patients, especially those patients with large diverticula. This approach demonstrated less morbidity than the open surgical procedure and is relatively simple. A further modification of this technique is the use of a flexible endoscope, as currently performed by some gastroenterologists outside the United States.

The first published description of this approach was done simultaneously by Ishioka et al¹ from Brazil and Mulder et al² from the Netherlands. Their technique is similar and uses electrocautery with a variety of instruments to incise the septum after placing a nasogastric tube for guidance. A recurrent problem encountered has been the difficulty in obtaining a stable position as well

as a clear visual field because of its location just past the piriform sinus of the pharynx. Since then, another series was published by Hashiba et al,³ as well as an update of the series from Mulder et al.⁴

When using the widespread EMR (WEMR) "hooded knife" device, we realized that it could be used for the treatment of a ZD.⁵ While performing endoscopy on the pig for various endoscopic projects, we realized that the hypopharyngeal pouch is very similar in appearance and structure to a ZD. While passing the WEMR device into the esophagus, we realized that its construction could stabilize and cut the septum, dividing the porcine hypopharyngeal pouch from the esophagus in a similar manner to the flexible endoscopic treatment of a ZD in a human being.

MATERIALS AND METHODS

Six female pigs that weighed 30 kg were used. The protocol was approved by our institutional animal care and use

Abbreviations: WEMR, widespread EMR; ZD, Zenker's diverticulum.

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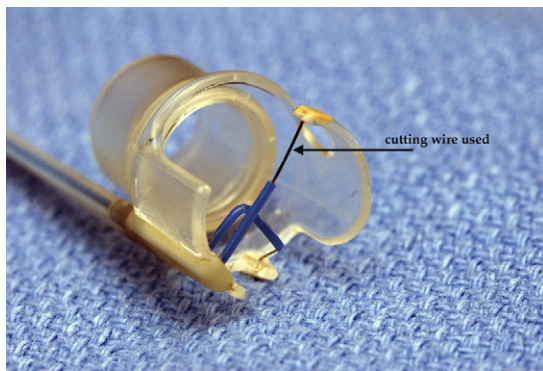


Figure 1. WEMR cap device. The *arrow* points to the transverse cutting wire used to cut the hypopharyngeal-esophageal lumen septum.

committee. All procedures were done with the pig under general IV anesthesia and intubation. Pigs were euthanized by chemical means. Three pigs were euthanized immediately after the procedure, whereas 3 more were euthanized after 3 weeks. A diagnostic Olympus gastroscope (GIF 130; Olympus America, Center Valley, Pa) was used, and the “hooded-knife” WEMR cap (Figs. 1 and 2) was placed onto the endoscope tip, with the cutting wire perpendicular to the axis of the scope. The WEMR device consists of a cap, with two fixed partially insulated cutting wires arranged perpendicular to one another, one intended for longitudinal cutting (cephalad-caudad) and the other for transverse (lateral) cutting (Fig. 1, arrow). The transverse cutting wire was used; the wire is set back from the rim of the cap by 1 mm and is exposed 5 mm. The cap is notched at the wire location to allow tissue contact. The notch is set back 7 mm from the cap margin. The cap has an outer diameter of 13 mm and is 1 cm deep. Both wires run from the cap onto the outside of the endoscope insertion tube, so the accessory channel is free to be used for other accessories, such as a needle for epinephrine injection or a clipping device in the case of bleeding. Cutting is done by pushing gently with the endoscope (Fig. 2A). The clear cap stabilizes the wire during cutting, spreading the cut tissues apart, and protecting the hypopharyngeal wall from contacting the wire. Changes in the cutting axis are made only by manipulating the endoscope tip, so that the wire is always centered in the endoscopic image, as is the point of contact for the incision (Fig. 2B). The cap edge is in contact with the uncut septum and the pouch surface all the time. This maintains the point of cutting within the set-back position of the wire, with the cap rim functioning as a “stopper” to prevent overextending the cut distally.

Three pigs were euthanized immediately after the procedure, and careful dissection of the hypopharyngeal neck area was performed, with meticulous inspection of the cut area to exclude perforation. The other 3 pigs were alive for 3 weeks and then underwent an endoscopy. A barium swallow was performed in one pig. This pig was placed in a specially constructed cage and was fed chow mixed with

Capsule Summary

What is already known on this topic

- Endoscopic treatment of Zenker's diverticulum (ZD) could be the preferred approach in high-risk patients, especially those with large diverticula, but maintaining a stable position and visual field is challenging.

What this study adds to our knowledge

- Six pigs underwent total uncomplicated excision of the porcine hypopharyngeal pouch septum, a model of ZD by using a prototype widespread EMR device cap that provided a stable position throughout the procedure and a protective rim that controlled the incision.

barium while fluoroscopic images were recorded. Afterward, the pigs were euthanized, and careful neck dissection was performed to extract the neck area en bloc.

RESULTS

The procedure was technically simple to perform. The average time for completion was 5 minutes (4:30 to 5:46). Minor bleeding occurred in the first pig when using 20 W of pure-cutting current. Therefore, in the next 5 pigs, blended current (20 W) was used. Bleeding was easily controlled by injection of a 1:10,000 saline:epinephrine solution. The incision was extended as far down the septum as allowed by the cap design (Fig. 2C and D). After completing the incision, the septum almost completely disappeared (Fig. 2E). After 3 weeks, a rhomboid-shaped defect was apparent at the level of the hypopharyngeal septum (Fig. 2F). The endoscope could easily pass through and into the esophagus without resistance. There were no obvious complications, such as a sinus, a fistula, a gross perforation, an abscess, an ulceration, or a stricture. In the immediately euthanized pigs, no complications were evident; specifically, no air dissection or perforation was apparent. In the remaining pigs, an endoscopy showed a small, less than 1-cm residual septum with an anteroposterior scar. In the one pig that underwent a barium swallow, there was no pouch evident. The “opened” pouch area only showed some angulation. Barium freely passed into the esophageal lumen.

In conclusion, we showed that a prototype “hooded-knife” WEMR cap device can be used to incise the septum in an animal model that simulates a ZD. The use of this cap-type device has potential advantages over other devices used for incising the Zenker's septum. The specific advantages are as follows: a stabilized incision permitted by the fixed position of the cutting wire, protective isolation of the septum from the surrounding pharyngeal walls, a clear field of view during cutting

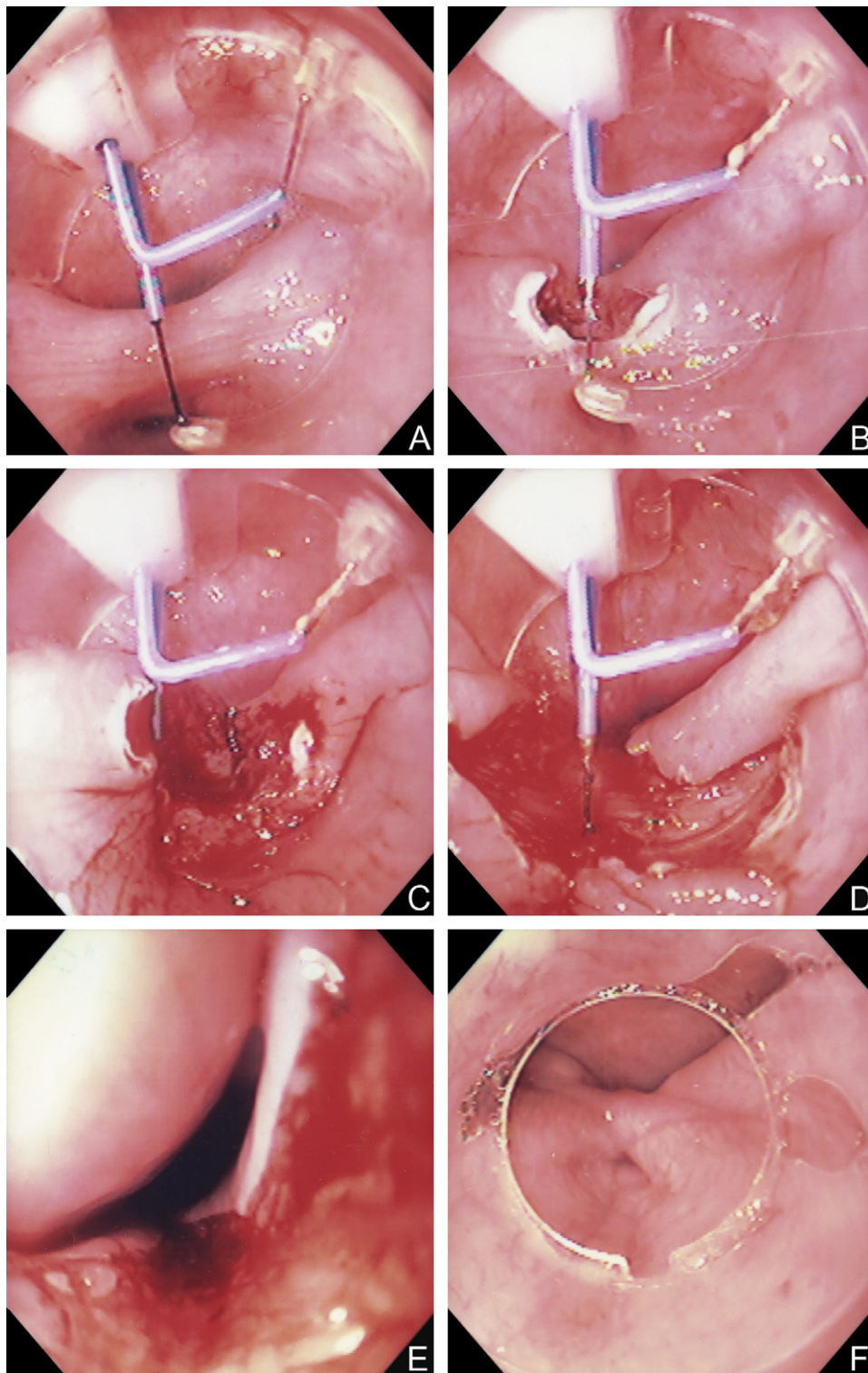


Figure 2. **A**, Endoscopic view of the WEMR cap device in place, above the septum is the esophageal lumen, below the septum is the hypopharyngeal pouch. **B to D**, Transverse cutting wire cutting the septum. **E**, Complete transaction of the septum to the base of the hypopharyngeal pouch, with the cap rim functioning as a “stopper” to prevent overextending the cut distally. **F**, Endoscopic image of healed incision, showing esophageal lumen on the top and trivial residual hypopharyngeal pouch base on the bottom.

provided by the cap edges, and avoidance of an overextended incision because of the “stopper” effect from the recessed cutting wire.

A cap was previously used to facilitate endoscopic incision of the ZD.⁶ To improve visualization, an oblique cap was used, with the longer side directed into the lumen

of the diverticulum. The investigators thought that this provided better visualization of the septum and a more stable position. However, the incision was accomplished by anteroposterior strokes of a needle-knife. This can only be directed by moving the tip of the endoscope, which moves the cap relative to the point of incision, destabilizing this critical position.

Another modification of flexible endoscopic treatment of the ZD was the use of a special overtube with two lips (similar to the Weerda diverticuloscope),⁷ at the distal end, which are directed into the lumen of the esophagus and diverticulum, each straddling the septum. Clearer isolation of the septum was accomplished and allowed cutting motions to be independent of the overtube.

We believe that this style of device, a cap-based cutting wire, allows a more simplified and consistent method, which might popularize this procedure among GI endoscopists. The device used in this study has several design features that would require revision if it were to be adapted exclusively for treatment of a ZD. A more ideal cutting cap would contain a single wire, oriented perpendicular to the cap wall. The exposed or cutting portion of the wire should be at least 5 mm in length and likely longer to accommodate the range of thicknesses encountered with a Zenker's septum. The edges of the caps used in this study contained projections that would enable positioning of the individual cutting wires to make longitudinal and circumferential mucosotomy incisions. A modified cap for ZD application would not need these projections and would benefit from either smooth edges or vertical notches to fit onto the septum and better position the wire.

DISCLOSURE

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