Original research

Double-stapling technique for transhiatal distal esophageal resection: Feasibility test in a cadaver model

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ABSTRACT

Objectives: To assess the feasibility of a new surgical technique for the resection of the distal third of the esophagus and/or cardias for neoplasm.

Methods: This surgical technique consists of two steps:

1. Insertion of the anvil of a common Entero-Enteric-Anastomotic Surgical Circular Stapler (EEATM) without hand-sewn securing.

   For this purpose we built a stainless steel support bar for the anvil that is thinner than the freespace of a standard linear suturing stapler (TATM). The support bar holds up a push rod that can be adapted to the hooking—unhooking of the anvil.

2. Anchoring the anvil to the proximal esophageal stump by suturing directly the esophagus with the TATM over the support bar, mobile and thus unhooked from the anvil, in order to perform the esophago-enteric anastomosis with the classic circular stapler EEATM (double-stapling).

Results: We performed our new technique on five cadavers. We did not encounter any difficulty during the procedures. We tested the anastomosis with hydropneumatic assessment without recording any leaks. The esophago-enteric anastomosis was then opened without finding any mechanical defects related to the procedure.

Conclusion: It can often be very difficult to fashion a safe hand-sewn pouch or a purse string around the anvil of an EEATM during the resection of the distal third of the esophagus or the cardias by a trans-hiatal approach. Moreover, there is no standardized procedure to minimize anastomotic leak. To avoid these mechanical problems we designed this innovative procedure, which is considered to be reproducible without significant training.

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1. Introduction

Stapled esophago-enteric anastomosis is a well known and standardized technique: the anvil of the stapler is placed in the esophageal stump and then secured; the body of the stapler is inserted directly into the lumen of the viscera selected for canalization recovery, and the anastomosis is performed by firing the stapler.

The securing of the anvil is historically carried out with various techniques: hand-sewn pouch, purse string, rake. These techniques all have the same characteristic: they need to be performed before the anvil is inserted into the esophageal stump.

We stress the importance of this point: it can often be very difficult to fashion a safe hand-sewn pouch or a purse string around the anvil during a resection of the distal third of the esophagus by a trans-hiatal approach. Moreover, there is, at present, no standardized procedure to minimize anastomotic leak. To avoid these mechanical problems we designed an innovative, easy, useful procedure, which is considered to be reproducible without significant surgical training.

This surgical technique is similar to the well known Knight & Griffen double stapling [1] already described for rectal resection. The final goal is to bypass the classic securing of the anvil and, moreover, to achieve a much more radical extension during the classic trans-hiatal esophagectomy.

The technique involves two steps: the first one consists in the insertion of the anvil through the esophageal stump, followed by anchoring of the anvil with a linear stapler.
To insert the anvil safely without hand-sewn securing, we built a stainless steel bar to support the anvil, obviously with the same diameter as the distal part of the anvil, but thinner than the free-space of a standard linear suturing stapler (TATM).

Thus, at the end of the first step, easily performed without any securing device, it is very simple to anchor the anvil to the esophageal stump by directly suturing the esophagus with the linear suturing stapler TATM and then perform the esophago-enteric anastomosis with the classic EEA circular stapler (double-stapling).

To assess our new technique we performed a feasibility test in a cadaver study.

2. Materials and methods

A total of 5 fresh (non-embalmed, non-preserved, time of death under 24 h) human cadavers were studied. There were 3 male cadavers. The mean age was 65 (49–68) years. All cadavers were autopsied at the Centre Hospitalier Universitaire of Nice.

Cadavers with thoracic or abdominal trauma or those likely to have previous abdominal disease and abdominal or thoracic surgery were excluded from the study.

The feasibility test was done by performing an esophagojejunal anastomosis on all five cadavers in the supine position with a xifo-pubic laparotomy.

2.1. Operating technique

The hepato-gastric ligament and Bertelli’s membrane were first transected, then the abdominal esophagus was carefully dissected to the distal thoracic third (Fig. 1A). For this purpose the vagus nerves were identified and sectioned.

The distal third of the esophagus was then transected and the free margins suspended on surgical pliers (Fig. 1B).

After oiling the esophagus and the anvil of a EEA circular stapler, the anvil was inserted into the lumen without hand-sewn securing and/or making a purse string to tighten the esophagus around it. The anvil was held up by a stainless steel support bar (Fig. 1C–D) shaped so that it could not be penetrated by the common stitch of a mechanical stapler; the bar has the following dimensions (Fig. 2): width = 6 mm (to the same as the width of the push rod); thickness = 1 mm, less than the freespace of a standard linear suturing stapler (TATM) ready to fire; length (of this prototype) 22.5 cm.

The support bar (Fig. 2) is characterized at its extremity by a push rod to anchor the anvil of a common EEA circular stapler. The push rod can be adapted to the hooking – unhooking of the anvil.

The length of the support bar allows us to insert the anvil deeply into the esophageal lumen.

Once the anvil has been inserted, the esophagus was secured and stapled around it by using a TATM linear stapler (Fig. 3A).

The linear stapler was locked over the support bar and then fired. At the end of the procedure, the free excess esophageal edge was transected, obtaining a string of tissue.

The result (Fig. 3B) was the complete closure of the esophageal stump at the edges of the support bar; the bar was movable and then retractable, allowing us to pull out the push rod of the anvil (Fig. 3C) that was thus just above the closed esophageal stump.

We then performed the esophagojejunal anastomosis with the standard technique by using an EEA (Fig. 3D).
3. Results

We did not encounter any technical procedure-related difficulties during the feasibility tests.

The procedure was easily reproduced on all the cadavers by two surgeons with different experience in esophageal surgery and by a resident.

No mechanical complications related to the use of the TATM linear stapler on the support bar, or difficulties in the hooking — unhooking of the anvil from the push rod were recorded.

Once the linear stapler had been fired, the support bar was easily retracted in all the feasibility tests.

At the end of the procedure, the esophago–jejunal anastomosis was subjected to the hydropneumatic test. A Foley catheter was inserted into the jejunal side of the anastomosis and secured by a hand-sewn pouch, while the distal third of the esophagus was clamped 2 cm beyond the anastomosis.

The hydropneumatic test was done first with water, then with diluted Methylene Blue without recording any anastomotic leak.

Finally, the esophago–jejunal anastomosis was carefully examined (Fig. 4); we did not find any surgical stitches inside the visceral lumen, nor traumatic distortion of the perianastomotic tissue; macroscopically the esophageal anastomosis resembled the ones performed with the standard techniques. The anastomotic rings were complete without macroscopical alterations.

4. Discussion

Distal esophageal adenocarcinoma is the most common type of esophageal cancer in Europe and in the USA [2].

Surgical approaches for the treatment of these lesions include trans-hiatal esophagectomy and trans-thoracic esophagectomy with the anastomosis in the chest or in the neck.

Controversy exists regarding the best surgical approach and, moreover, the type of anastomosis that provides the lowest rate of leaks and strictures [3,4].

Our surgical technique consists mainly of two steps. 1. Insertion of the anvil of a common Entero-Enteric-Anastomotic Surgical Circular Stapler (EEATM) without hand-sewn securing.

For this purpose we built a stainless steel support bar for the anvil that was thinner than the freespace of a standard linear suturing stapler (TATM). The support bar holds up a push rod that can be adapted to the hooking—unhooking of the anvil.

2. Anchoring the anvil to the esophageal stump by directly suturing the esophagus with the TATM over the support bar, mobile and then unhooked from the anvil, in order to perform the esophago—enteric anastomosis with the classic circular stapler EEATM (Fig. 5A—B).

The aim of our new technique is to reduce the technical difficulties related to hand-sewn securing in a deep and narrow anatomic location, typical of the trans-hiatal approach to esophageal surgery. The use of the TATM linear stapler to secure the anvil into the esophageal lumen could, in our opinion, reduce operator-dependent error. We also believe that the limitation of the oncologic resection of the distal third of the esophagus by a trans-hiatal approach may be related to the technical difficulties of making a safe hand-sewn pouch or a purse string around the anvil.

Other techniques have been proposed to solve the problem, [5,6] such as the trans-oral access for the transit of the anvil-OrViTM. Complications specific to the trans-oral passage of the OrViTM 25-mm device have been reported but are rare [7].

They consist of premature dislodging of the anvil from the delivery tube, necessitating manual or endoscopic removal of the anvil or hypo-pharyngeal or esophageal mucosal injuries.

We must stress at this point that our technique is designed to be laparotomic-open and the voluntary manual control mechanism for the hooking — unhooking of the anvil from the push rod allows...
the surgeon to manage the placement of the anvil under direct vision in every step of the operation. Therefore there are no specific contraindications to the placement of a 25–29 mm anvil.

Our technique may thus be a valid alternative to Mini Invasive Esophagectomy, especially for cases of locally advanced esophageal/cardial tumors.

The oncological advantages may be related to the possibility of a longer proximal esophageal resection by the trans-hiatal approach and, moreover, to obtain a double anastomotic ring (the standard anastomotic ring plus the additional one from the linear stapler TATM) with a supplementary extemporary histopathological examination.

If the excess tissue after the TATM closure is positive for neoplasm, our technique allows the surgeon simply to proximally extend the resection by placing a second TATM cranially.

We believe that the only critical point is represented by the careful placement of the anvil over the support bar in the middle of the esophageal lumen just before the TATM closure.

Thus, in our opinion, the first operating surgeon must keep the support bar centered in the visceral lumen, while the second operating surgeon closes the linear stapler TATM.

To further reduce operator dependent error, it would be possible to construct a dedicated linear stapler designed specifically for this surgical technique.

5. Conclusions

It can often be very difficult to fashion a safe hand-sewn pouch or a purse string around the anvil of a EEATM during the resection of the distal third of the esophagus or the cardias by a trans-hiatal approach. Moreover, there is no standardized procedure to minimize anastomotic leak.

To avoid these mechanical problems, we designed this innovative procedure, which is considered to be reproducible without significant surgical training.

We believe that our technique will reduce operator-dependent errors and may be proposed in mini-invasive esophageal surgery without significant related complications.

Ethical approval

No Ethical Approval was required, because the study was done over cadavers freely given for scientific purposes.

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Author contribution

S.G. was the principal inventor of the technique and of the support bar, regularly patented.

F.D. mainly wrote the manuscript and was the secondary inventor of the support bar, regularly patented.

L.P. Reviewed the literature.

R.B. was the supervisor of the manuscript on the basis of his Pathologic experience.

C.C. was the supervisor of the manuscript on the basis of her Thoracic Surgery experience.

M.G. was the supervisor of the manuscript on the basis of his General Surgery experience.

Conflicts of interest

The Authors declare no conflicts of interest.