

A Stapling Instrument for End-to-end Inverting Anastomoses in the Gastrointestinal Tract

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A stapling instrument is described for end-to-end inverting anastomoses applicable principally to low rectal anastomosis or esophagogastric or esophagojejunal anastomosis. The instrument creates an inverting anastomosis held by a double staggered row of stainless steel wire staples creating an anastomosis 21.2 mm internal diameter with no significant inverted flange. The early experience is encouraging.

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IN 1960,⁷ AT THE Scientific-Research Institute of Experimental Surgical Apparatus and Instruments in Moscow, a tubular instrument was devised for performing end-to-end anastomoses in the gastrointestinal tract at the top and bottom of the peritoneal cavity, where these anastomoses may be technically difficult, *i.e.*, low rectal anastomoses and esophagogastric or esophagojejunal anastomoses.^{8,9,14} Eleven years ago, we conducted a series of experiments on dogs with that instrument. In essence, the instrument looks somewhat like a sigmoidoscope with a handle, except that the obturator (nose cone) of the sigmoidoscope protrudes beyond the cylinder. For a low rectal anastomosis, the instrument was inserted through the anus, the nose cone advanced well beyond the cylinder, the distal end of the rectum tied in a pursestring over the staple-carrying cylinder of the instrument and the proximal bowel tied in a purse-string over the anvil-carrying nose cone. The instrument was then closed—nose cone against cylinder—and this approximated the two closed ends of the bowel firmly, and the staples were fired. Simultaneously with the firing of a single circular row of staples from the end of the cylinder, in which they had been placed by hand, a circular knife just inside the cylinder cut the double diaphragm created by the two purse-string sutures.

We performed the operation successfully in 12 successive dogs producing anastomoses as low as 2 cm from the mucocutaneous junction. There were no deaths, although in several animals inspection dis-

closed a small mucosal dehiscence, but without abscess or infection. We were impressed with the precision of the instrument and the minuteness of the inversion. It was difficult, immediately after the operation, to palpate the anastomosis by digital rectal examination. Several mechanical and technical features concerned us despite a number of enthusiastic reports from Russia. The instrument was rather difficult to disassemble and reassemble, for cleaning. The circular knife was a permanent part, and this would pose problems in maintaining a sharp cutting edge. In reassembling the instrument, we found it difficult to register the nose cone properly, so that we could be confident that the staples in the end of the cylinder would fit exactly into the anvil's grooves in the nose cone, for precise formation of the B-shaped staples. We were further dissuaded from applying this instrument clinically, because it inserted only a single row of staples, and in the very low anastomoses in which it would find its greatest use, we thought it might be difficult to apply an external row of reinforcing manual sutures. In some of our dogs, small dehiscences in the anastomosis were seen. Nevertheless, there continued to be favorable publications from the Soviet Union⁹ and more recently, several from Western Europe,^{14,15} especially with a newer version (SPTU) of the original instrument. The modification of this instrument, which has now been achieved in this country,* in common with a number of the stapling instruments widely in use in American surgical clinics, has solved many of the drawbacks of the Russian instrument by placing the small moving parts of the mechanism within a disposable cartridge which locks to the end of the tubular shaft of the instrument, within which is the activating mech-

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anism. The result is a prepackaged, presterilized, disposable cartridge loaded with two staggered rows of staples, the circular knife included within the cartridge.

Technique of Application to Low Rectal Anastomosis

The patient should be either in the combined lithotomy-Trendelenburg position, characterized by wide abduction of the hips and little or no flexion with simultaneous draping of the abdomen and the

perineum, or else in the oblique, modified Simms' position (as employed by Localio in abdominosacral procedures).¹⁰ After the rectum has been appropriately freed, the pursestring clamp (which resembles a Furniss clamp with the tips of the serrations cut off) is applied at the proposed levels of resection and the straight needles are passed through the clamp, as shown in Figure 1A, to form the pursestring suture. The bowel is transected proximally and distally, on the specimen side, with the pursestring clamp in place

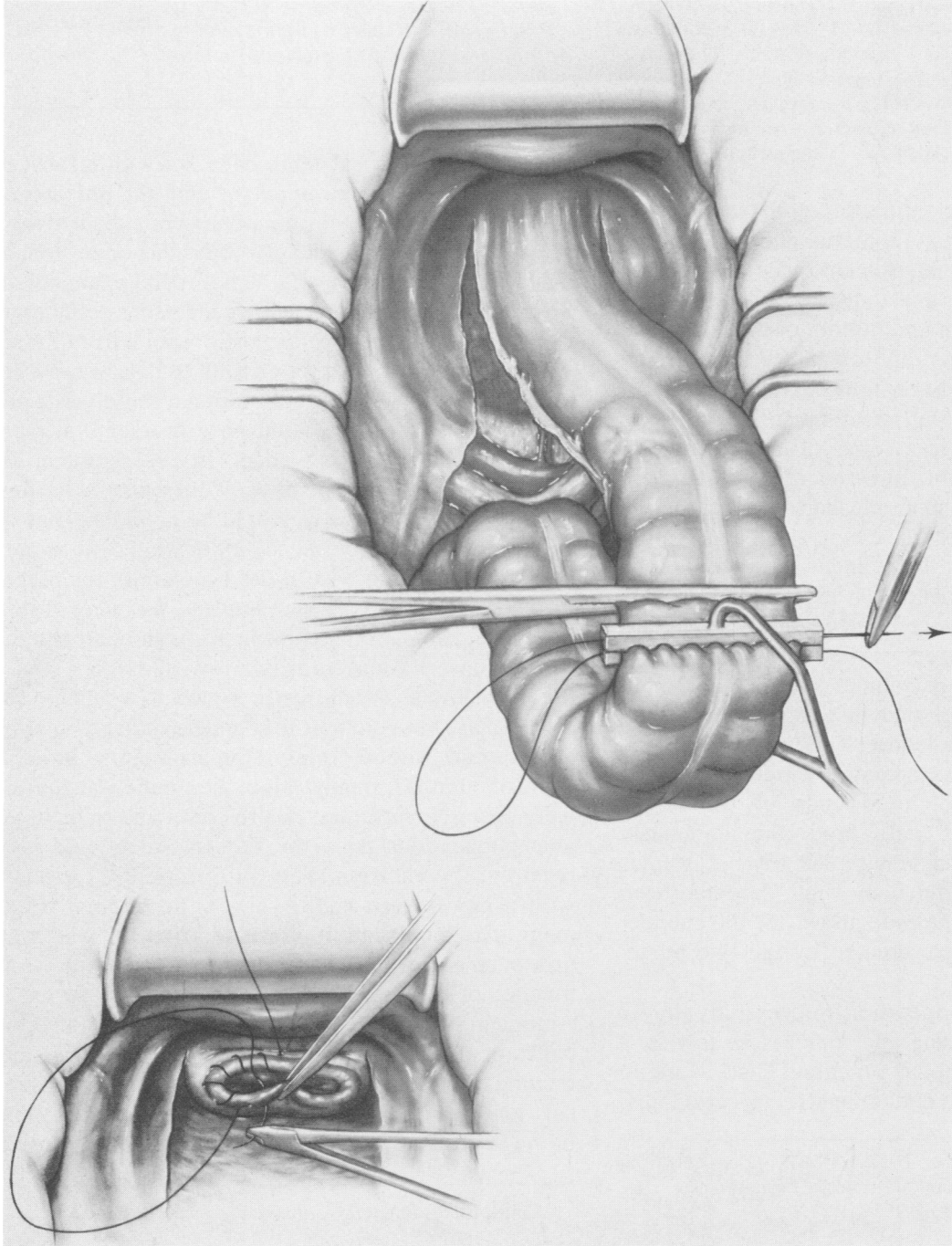
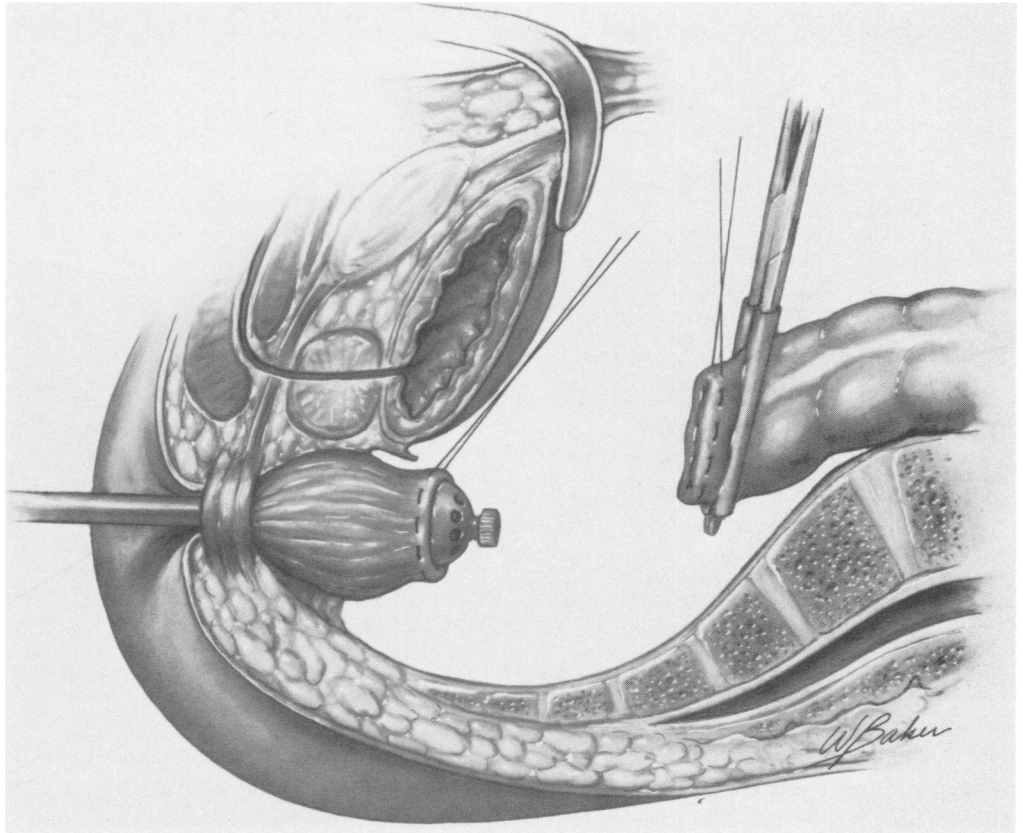


FIG. 1a. Technique of end-to-end low rectal anastomoses with the E.E.A. Placement of the pursestring sutures. The proximal pursestring suture is shown being placed with the aid of a modified Furniss clamp, the serrations of which have been cut so that they do not digitate. When the needle is passed through in one direction and brought back in the other, it grasps only one wall of the bowel on each side as shown in Figure 1b. In a narrow male pelvis, there may not be enough width to employ this technique and shown here is an over-and-over purse-string suture for the distal end of the rectum, made with a strong smooth monofilament suture. A purse-string made in this fashion avoids the introduction of excessive material into the limited space within the stapling cartridge.

FIG. 1b. The proximal and distal purse-string sutures have been introduced. The assembled instrument is passed up through the anus until the nose cone protrudes through the end of the rectum.



and used as a guide for this transection. If the distal line of resection is to be very low, particularly in a male pelvis, it may be difficult to employ this technique. In that case, the pursestringing is produced by a run-

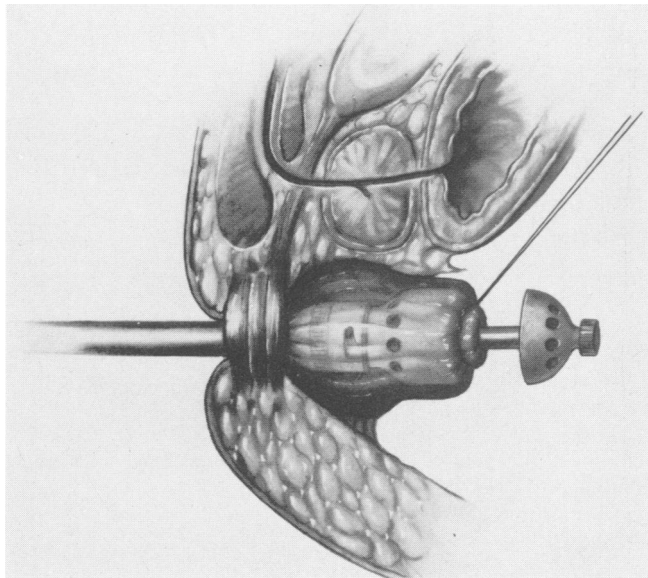


FIG. 1c. The nose cone is advanced by turning the wing nut at the other end of the instrument in a counterclockwise direction, and the purse-string strongly tied about the slender central shaft of the instrument. The staple-containing portion of the cartridge is now secured in the rectum.

ning over-and-over suture of heavy monofilament material placed manually over the edge of the distal segment (Fig. 1A). The assembled instrument, the disposable cartridge locked to the end of the cylinder, is now inserted through the anus (Fig. 1B). As the nose cone appears, the instrument is opened by turning the wing nut counterclockwise, and the nose cone, which contains the anvil for formation of the staples and a plastic disc for the knife to cut against, is advanced beyond the cut end of the rectum. The end of the staple-containing portion of the cartridge should still be within the rectum. The distal pursestring suture is now strongly tied around the slender central rod of the instrument, over this portion of the cartridge (Fig. 1C). The nose cone is advanced into the end of the proximal bowel and the proximal pursestring strongly tied around the central rod (Fig. 1D).

The nose cone is now brought down against the staple-containing portion of the cartridge by a clockwise rotation of the wing nut in the handle, pressing the bowel ends in tight approximation (Fig. 1E). When the markings on the instrument indicate that the tissues have been appropriately coapted, the pistol grip is squeezed (Fig. 1F). This drives in a double row of staples and cuts out the double diaphragm of bowel formed by the two purse-string sutures. The instrument is once more opened and the nose cone teased

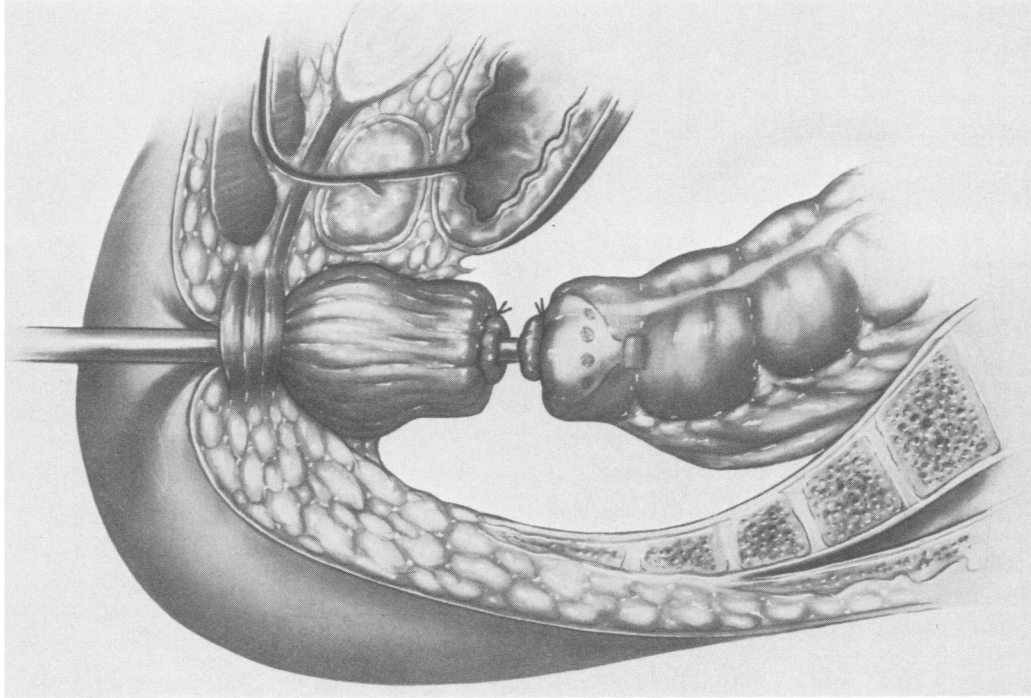


FIG. 1d. The nose cone containing the anvil portion of the cartridge is introduced into the proximal bowel and that purse-string suture tied securely.

down through the stapled suture line (Fig. 1G). No reinforcing sutures are required. The outside diameter of the cartridge is 31 mm, the diameter of the circular knife is 21.2 mm, so that a large, precisely circular anastomosis is produced, with minimal inversion (Fig. 1H). At this point, one must inspect the instrument to be absolutely certain that there are two unbroken rings of full thickness bowel around the central rod, guaranteeing that the staples have gone through the bowel wall of both ends, peripheral to the purse-string sutures.

As in our dog experience, the anastomosis is almost impalpable to the finger, and in a single patient sigmoidoscoped at five days, the anastomosis could not easily be identified. Our experience with rectal anastomosis with this instrument is in six patients, with no leaks, failures or complications.

It is obvious that there are a number of other situations in which the instrument can be employed for end-to-end or end-to-side anastomosis. We have employed it for a Billroth I anastomosis in which the stomach was stapled and transected in the ordinary way. The end-to-end anastomosing instrument (EEA)—the nose cone not yet applied to it—is inserted through an anterior gastrotomy and the central rod passed through a small pursestrung stab wound in the midposterior gastric wall, some 3 cm proximal to the stapled stomach end. The staple-containing portion of the cartridge now rests within the stomach and the nose cone is attached to the central rod outside

of the stomach and passed into the duodenum. The duodenal pursestring is tightened around the central rod and the nose cone and staple cartridge are tightly approximated. The instrument is then operated, producing a beautiful circular Billroth I anastomosis, and is withdrawn through the anterior gastrotomy. The gastrotomy is closed mucosa-to-mucosa with the TA55 linear stapling instrument. The EEA instrument lends itself similarly to esophagogastrostomy, to

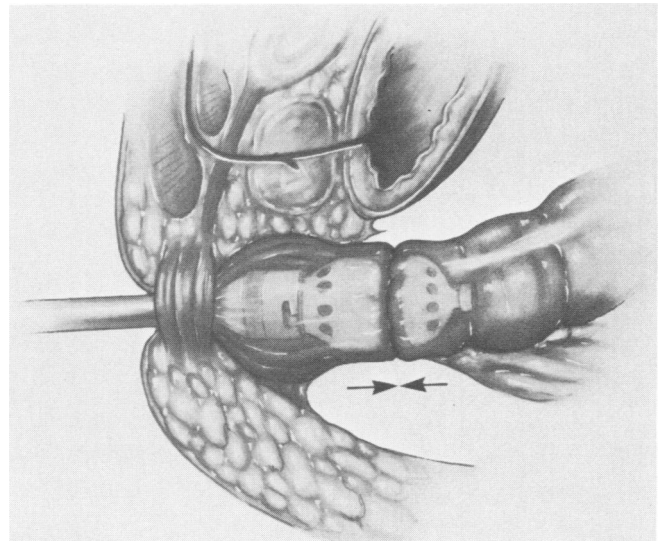


FIG. 1e. By clockwise rotation of the wing nut, the two ends of the cartridge are brought together apposing the purse-strung ends of the proximal and distal bowel.

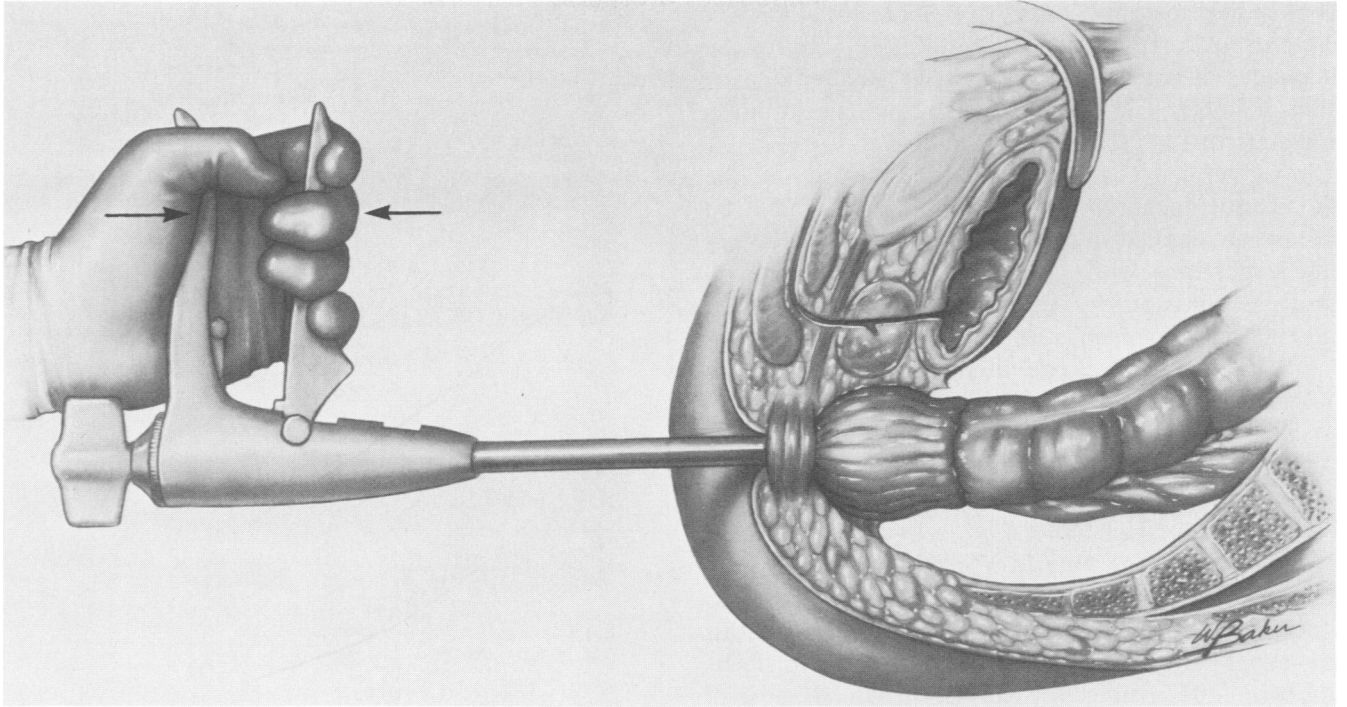


FIG. 1f. A squeeze of the instrument handle now drives in a double staggered circular row of staples and sends home a circular knife just inside the ring of staples cutting the double diaphragm made by the two apposed purse-stringed bowel ends.

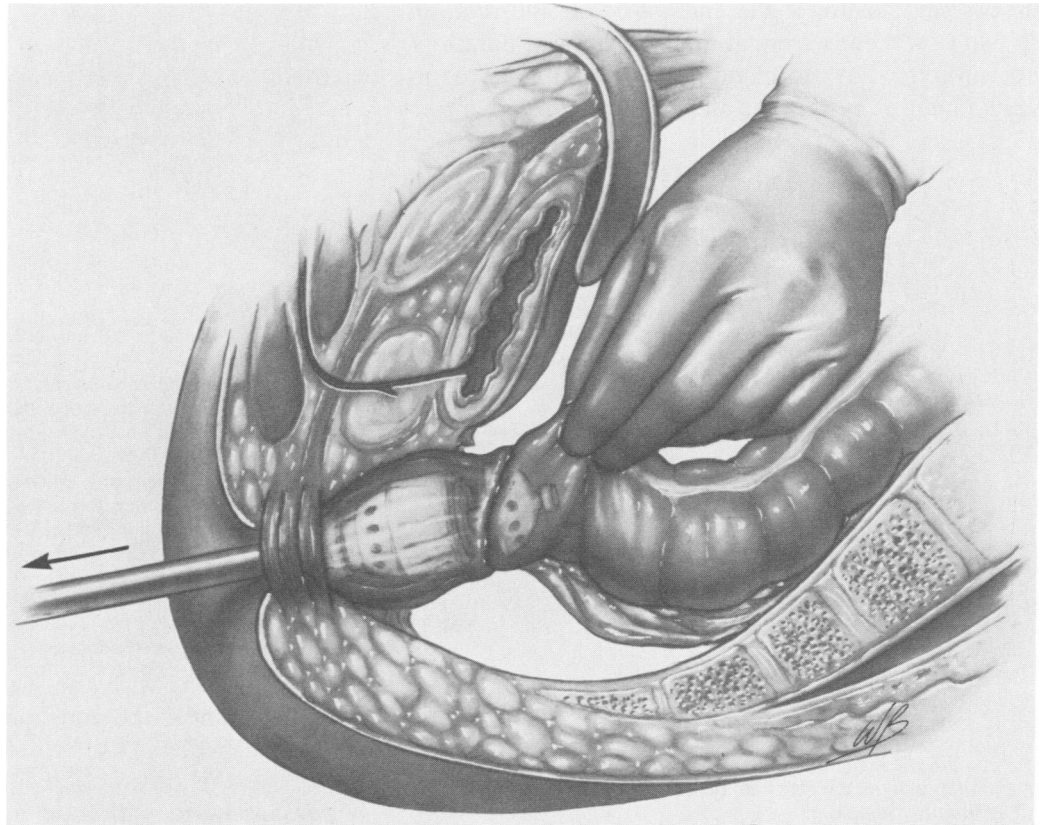


FIG. 1g. The wingnut having been once more rotated counterclockwise to open the cartridge, the instrument is teased out of the anastomosis and withdrawn.

esophagojejunostomy, and to esophagocolostomy. The present cartridge may be found too large for the esophagus of some patients, and two smaller sizes—outer diameters 28.6 and 25 mm and anastomosis diameters of 18 and 15 mm are in design.

So far as concerns the safety and security of the anastomotic technique, the principles have all been extensively applied in the clinic. There is now a very wide experience with stapling sutures of the bowel, inverting and everting. The present staples, wire size and material, dimensions, formation in the classical B-shape, are those which are already in standard use in the other instruments.¹¹⁻¹³ The actual low rectal anastomosis, after making two pursestring sutures, is no more than the application of modern engineering techniques to the bulkhead, low rectal anastomosis devised by William Stewart Halsted.

In 1910, before the American Surgical Association,^{3,4} Halsted presented one of a number of techniques with which he was to experiment over the next decade, his final paper being published the year of his death.^{5,6} His final technique involved the passage through the anus of a sheathed knife which the surgeon then guided through the abutted purse-stringed ends of the rectum and colon (Fig. 2). It is fascinating to read that he had very nearly hit upon an instrument which would excise the diaphragm with a circular punch. Thus, after the purse-string closure of the ends of colon and rectum, the two bowel ends were abutted with the usual Lembert sutures. The problem now was to restore intestinal continuity through the two closed ends.

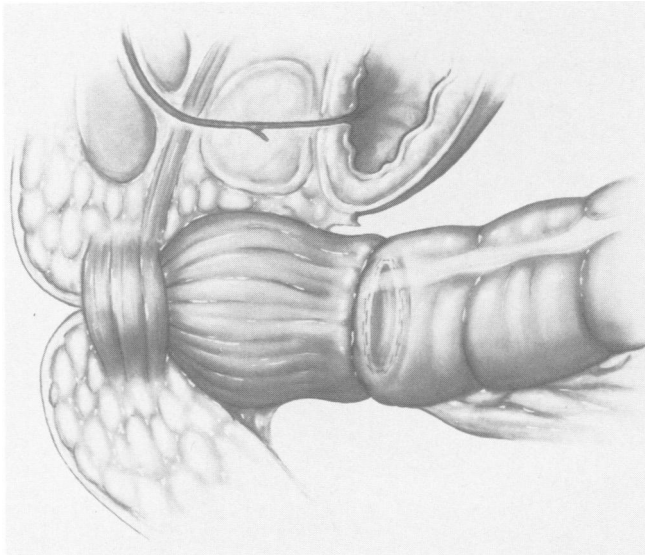
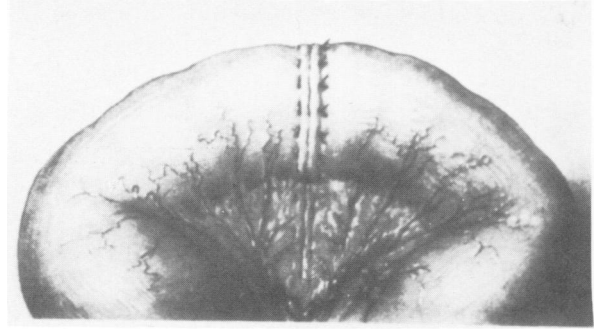
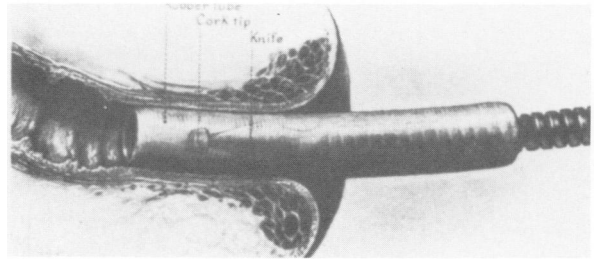


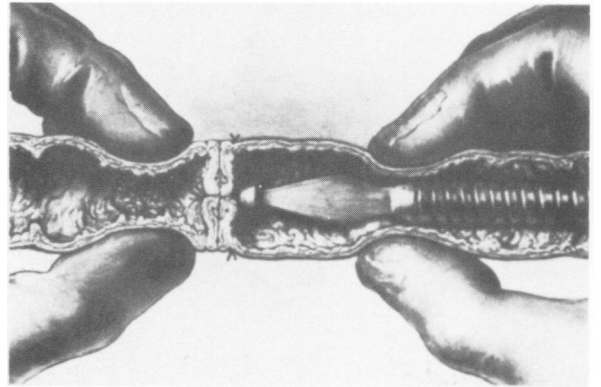
FIG. 1h. The completed anastomosis. One must be absolutely certain that two intact rings of full thickness bowel are on the shaft of the instrument.



1.—Suture Completed



2.—The Knife in Transit Through the Rubber Tube Which Protects The Sphincter.



3.—The Knife Has Been Pushed Up to the Diaphragm by the Outside Assistant.

FIG. 2. Halsted's bulkhead anastomosis. In 1, the pursestringed ends of the bowel have been sutured together. In 2, the knife is shown introduced through a protecting sheath. In 3, as the sheath has been withdrawn, there is seen a small cork button which protects the knife point and which the operator now squeezes off the knife point permitting the knife to be passed through the diaphragm. Halsted did not report any clinical experience with this technique which had succeeded in animals. (Reprinted from Johns Hopkins Hosp. Bull. 32, 1921).

“To eliminate this diaphragm, I devised a sharp-edged punch, with the idea of introducing it at a higher point in the bowel through a lateral opening, slipping it down to the diaphragm, and pressing it through this obstruction and into a cork introduced per anum, to withdraw both cork and punch by

means of a string attached to the former. This method was not tested.”

An obvious use of the EEA instrument is in the treatment of esophageal varices. The instrument is inserted to the esophagogastric junction through a gastrotomy, the esophagus strongly ligated down to the shaft of the opened instrument, the instrument closed and fired, resecting a collar of esophagogastric junction, essentially a one-stage Boerema operation.¹ We tested this principle in the laboratory with Dr. Larry Carey several years ago. Vankemmel, in Lille, France,¹⁵ has applied it clinically with what appears to be satisfactory results, and Dr. Carey² has now twice applied the American instrument, without rebleeding.

Summary

We describe a stapling instrument for end-to-end inverting anastomoses applicable principally to low rectal anastomosis or esophagogastric or esophagojejunal anastomosis. The instrument creates an inverting anastomosis held by a double staggered row of stainless steel wire staples creating an anastomosis 21.2 mm internal diameter with no significant inverted flange. Early experience is encouraging.

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