Staplers In Gastrointestinal Surgery

Essay

Submitted in Partial Fulfilment
of the Master Degree in *General Surgery*

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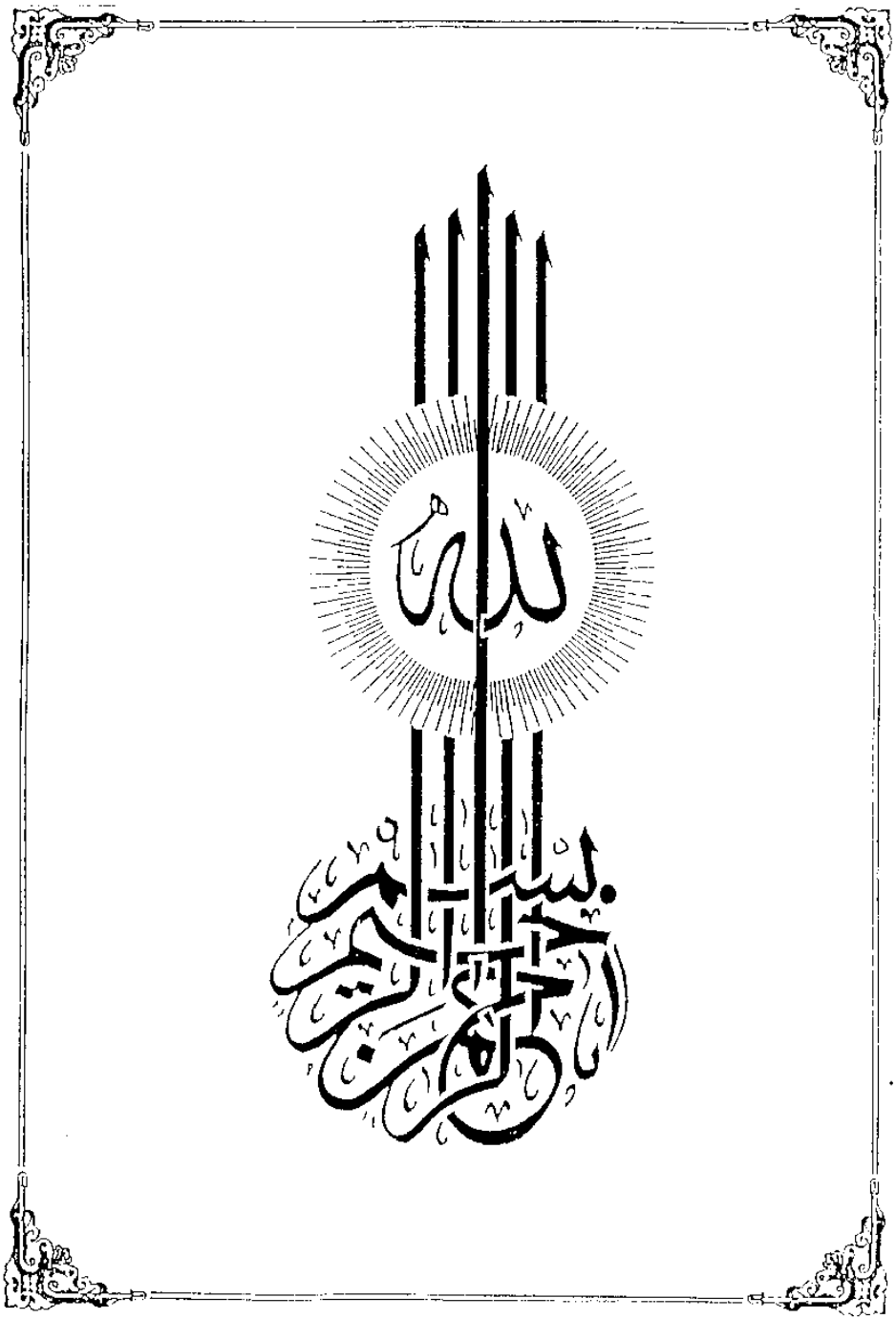
1987

Acknowledgement

I would like to express my deepest gratitude to Professor Dr. Hamdy Mahmoud Abd-Allah for the kind advice, encouragement, and supervision he offered throughout the course of this work.

Special grateful thanks and appreciation to Dr. Mohamed Abd-El Moneim. His sincere continuous help, encouragement, and supervision provided me all the facilities during the conduction of this work.



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DEVELOPMENTAL BACKGROUND

Since 1908, when Hültl presented the first intestinal stapler at the Hungarian Society for Surgery, several improvements have changed the initial devices into accurate and reliable instruments. The intense efforts of the Scientific Research Institute for Experimental Surgical Apparatus and Instruments in Moscow in the 1950's, covered a wide spectrum of problems related to stapling. These included tissue thickness, healing, metals used for the instruments and staples, and instrument design. The Soviet contribution has resulted in lighter and better designed instruments, and in the creation of the cartridge concept (manual loading) as well as simultaneous staple placement for the linear staplers. The suture material used (tantalum alloy K40HXM) cases the least tissue reaction of any such material known *(Gritsman, 1966)*.

In the 1960's, the surgical scene has been revolutionized by the introduction, in the United States, of a broad range of stapling instruments that solved the problems inherent in the Soviet instruments. These problems included hand loading, the necessity for partial disassembly before reinsertion of a new cartridge, and certain problems of weight and balance and function. The American instruments are capable of accepting disposable, preloaded, sterilized cartridges with the placement of all

moving parts into the cartridge. This transformed the instrument into a simple shell available for multiple uses depending on the cartridge. They also reaffirmed the use of fine staple materials and double staggered rows. The instruments have become available in a totally disposable form *(Steichen and Ravitch, 1980)*.

The Instruments

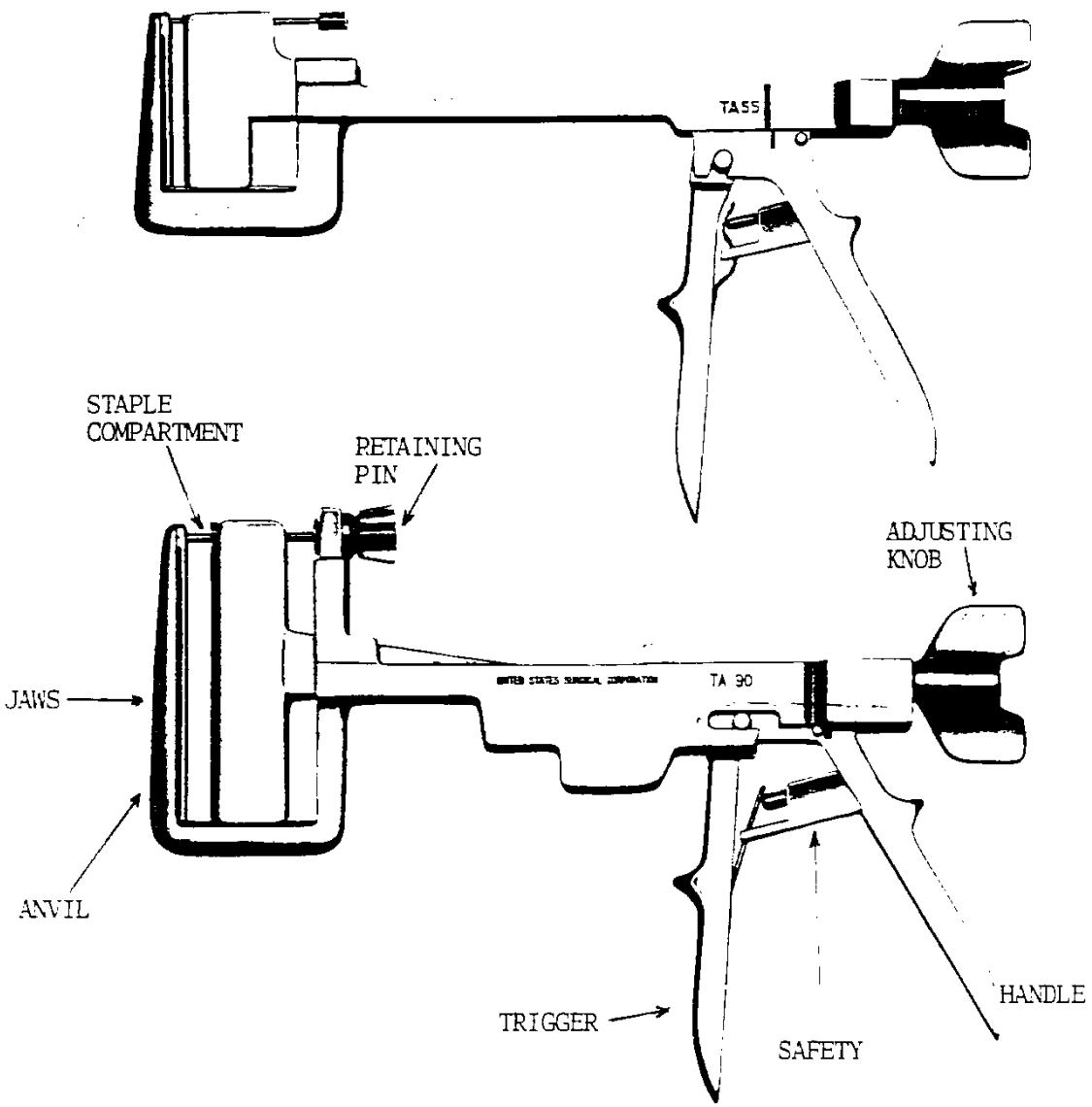
The basic stapling instruments are : [1] $TA_{30,55\&90}$, [2] GIA, [3] LDS, and [4] the EEA.

1. The TA instruments (Thoraco—abdominal):

They are like two nesting L-shaped arms whose long vertical arms slide upon each other when a wingnut at the end is turned. This maneuver approximates the short horizontal jaws (which contain the staple cartridge and the anvil for forming staples) until the tissues that are to be sutured have been compressed to the required degree. The squeeze of the handle drives in the staples.

The TA_{30}, TA_{55}, and TA_{90} instruments have similar mechanisms and differ only in the length of their jaws. There are two staple sizes: 3.5 and 4.8 mm, depending on the thickness of tissues being stapled.

The instruments are used to place a linear everting, mucosa-to-mucosa, double line of staggered staples. This simultaneously seals the viscous and provides haemostasis.



TA55 & TA90 instruments.

It is extensively and effectively used in closure of all portions of the gastrointestinal tract and for the closure of the GIA and EEA introduction sites *(Steichen and Ravitch, 1980)*. The healing of the anastomosis with an everting, mucosa-to-mucosa apposition is just as secure as that with the classical inversion and serosal apposition produced by Lambert sutures *(Getzen et al., 1966)*.

The TA30 has, in addition, a special cartridge loaded with fine, closely spaced staples (a 30-V vascular white cartridge) used for closing major vessels such as the pulmonary artery, the portal vein and the renal pedicle *(Pories, 1983)*.

2. The GIA (Gastrointestinal anastomosis):

Consists of two long slender limbs; one for the disposable staple cartridge and the other for the disposable anvil. The activating force, also disposable, is triple bladed. The two outer blades, each drives in two rows of staples. The central blade (the knife) follows behind the two blades at a distance of a staple and a half. When this assembly is pressed home, two double staggered rows of staples are introduced into the bowel, while the knife divides the tissues between the two middle rows, leaving two rows of staples on either side of the cut. Its ingenious design allows a rapid spill-proof transection, leaving the intestinal ends securely sealed *(Steichen and Ravitch, 1980)*.

The GIA stapler is probably the most used instrument among the staplers. It is probably most widely used to divide the intestines. In combination with the TA_{55} stapler, it can be used to produce anastomoses of varying sizes *(Pories, 1983)*.

Originally, the GIA instrument and its Russian counterpart were designed to achieve anastomotic side-to-side, minimally inverting, serosa-to-serosa anastomosis by placing each of the GIA limbs into a lumen of the gut to be anastomosed. The two openings through which the GIA instrument are placed are converted into one as the anastomosis takes place. This one orifice is closed by an everting mucosa-to-mucosa TA closure, in which case staple lines overlap, without any ill effect *(Steichen and Ravitch, 1980)*.

Anastomoses from the esophagus to the rectum are performed with the GIA instrument. The two limbs of the instrument must be mated and locked correctly without force, the staples driven home without force, resistance suggests improper assembly of the limbs. There is no tissue-retaining pin, and the operator must be certain that tissues to be divided are all within the staple bearing portion of the jaws. Mesentery and omentum must not be in the suture line, as their vessels will not be controlled. Anastomoses should be inspected and reinforced with fine sutures if a bleeding point is seen.

For the purpose of obtaining hemostasis, a special (SGIA) cartridge has been created that does not contain the dividing blade. With it, one introduces four staggered linear rows of staples, producing safe and hemostatic suture lines *(Steichen and Ravitch, 1980)*.

In using the GIA instrument for anastomosis, the resection of the specimen may follow the performance of the anastomosis and in fact may be an integral part of the TA closure of the common GIA opening *(Steichen and Ravitch, 1980)*.

3. The LDS instrument (Ligating and dividing stapler)

It places two clips of fine stainless steel on either side of a dividing blade. The instrument can be used in the simultaneous ligation and division of mesenteric, gastric, mesocolic, and omental vessels. The staples, before closure are U shaped, with the legs of the U being 5 mm. apart. The tip of the cartridge, which resembles a hook, is slipped around the structure or vessels to be ligated and divided. As the surgeon squeezes the instrument handle, the resulting closed pair of staples resembles a half-moon with the tissue securely clamped within the staples. The crimpling action is self-adjusting and accommodates to any amount of tissue within the confines of the staple. The half-moon staple closure has proved to be very secure. Immediately following staple closure, a knife blade in the cartridge is activated to divide the tissue between the closed staples. The distance between the staples is 1/4

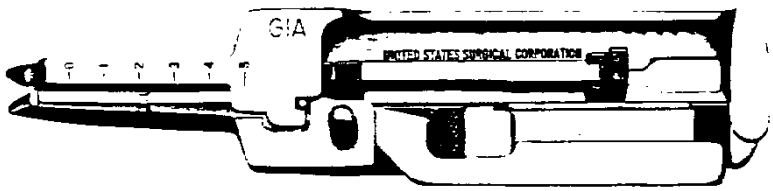
inch, a margin of 1/8 inch is left from the staple to the cut edge of tissue.

An automatic interlock prevents the knife blade and pusher from coming forward if no staples have preceded them. The staples have proved secure against the force of arterial blood pressure. The apparatus will safely secure a single short gastric vessel or the splenic artery and surrounding fat. A fail-safe mechanism prevents the instrument from closing if no staples are left in the magazine *(Ravitch et al., 1972)*. The instrument is supplied with a presterilized, disposable, loading unit, contains six or fifteen pairs of staples for repetitive use.

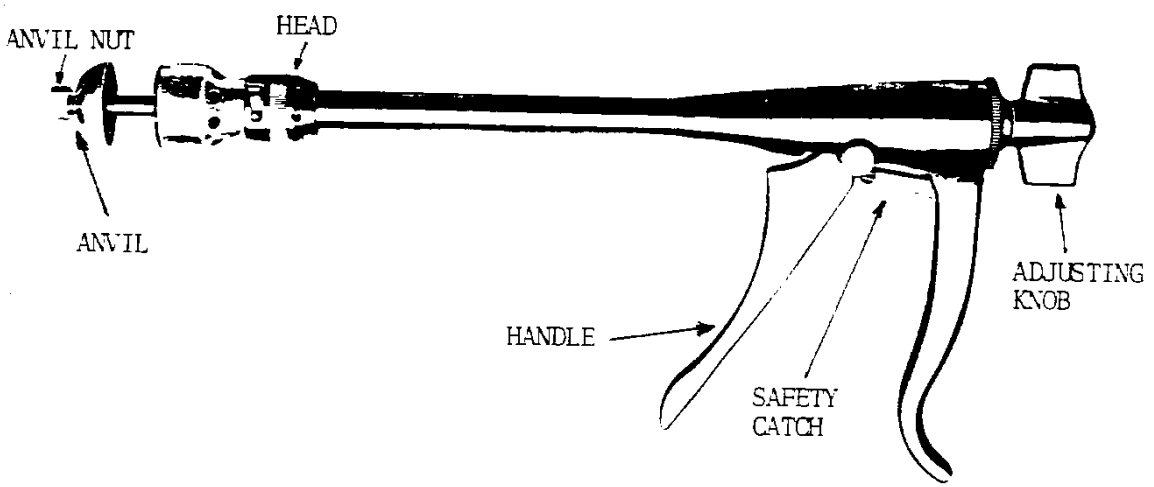
4. The EEA (End—to—end anastomosis)

The EEA instrument may well be the most important of the stapling devices but it is also the most difficult to use. The instrument is designed to join two tubular structures, such as stomach and oesophagus, or ileum and rectum. It is particularly useful in two procedures involving treacherous anastomoses: oesophageal resection and anterior resection and reanastomosis of the rectum *(Pories, 1983)*.

The EEA, the newest of the stapling instruments, is used in the creation of inverting end-to-end anastomoses *(Nance, 1979)*. The instrument is introduced into the lumen of the bowel through a natural orifice, such as the anus, or



GIA stapler.



EEA stapler.

through a stab wound in the gastrointestinal tract, proximal or distal to the proposed anastomosis. The choice of the EEA introduction site is decided by the technical ease with which the instrument can be placed into the gastric or intestinal lumen *(Steichen and Ravitch, 1980)*.

The EEA instrument is a tubular device somewhat resembling a sigmoidoscope. The head of the instrument contains a circular anvil and a cartridge harboring two circular staggered rows of staples and a central circular knife. At the other end, a handle for activating the instrument and a wingnut for separating or approximating the staple and anvil halves of the disposable cartridge. The bowel segments to be anastomosed are purse-stringed around the nose cone (anvil) and around the proximal portion of the cartridge, then approximated by turning the wing nut. A squeeze of the handle introduces two circular rows of staples and advances the circular knife which punches out purse-stringed doughnut rings of both bowel ends, thus creating an instantaneous inverting serosa-to-serosa, end-to-end anastomosis.

The metal EEA instrument is supplied with cartridges 31, 28 and 25 mm, in external diameter, and produce anastomoses, 21, 18 and 15 mm in internal diameter respectively.

The disposable EEA, which is also available with a conveniently curved shaft, also has a cartridge 20.9 mm in

external diameter that is useful for oesophageal anastomoses *(Steichen and Ravitch, 1980)*.

GASTROINTESTINAL ANASTOMOSIS

Healthy and supple segments of intestine with a good blood supply should be anastomosed. The anastmosis itself should be watertight, with an adequate stoma, and the suture line should be free from any tension *(Schwartz, 1985)*.

Types of Anastomoses

End–to–end anastomosis

This is the type most frequently used for reestablishment of small intestinal continuity and also for colocolostomy. Minimal to moderate disparity between the two limbs of the intestine, such as ileum and colon, can be compensated for by enlargement of the smaller lumen either by resecting it obliquely or by longitudinally dividing its antimesenteric border *(Schwartz, 1985)*.

The end-to-end anastmosis can be established either by sutures or by staple technique, using triangulation with three TA staplers, or using the end-to-end stapler *(Ravitch, 1974)*.

In the case of disparate lumens, a functional end-to-end anastmosis may be accomplished by closing the two ends of the intestine and carrying out a side-to-side anastmosis in immediate proximity to the closed ends. This may be performed by suture technique or using staples to close the two ends, then creating the anastmosis with a GIA stapler *(Schwartz, 1985)*.