

CLOSED VERSUS OPEN, SINGLE-LAYERED, ANASTOMOSIS — A REVIEW OF 35 ESOPHAGEAL AND 113 LARGE BOWEL CASES

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SUMMARY

Anastomosis breakdown remains a major threat in digestive surgery, most particularly whenever the esophagus or the large bowel are involved. Aiming to assess the relative role of two different techniques, in this context, a total of 148 anastomoses (January 1973 - September 1982) is analysed, 35 involving the esophagus (GROUP A) and 113 the large bowel (GROUP B). On Group A 15 anastomoses (Sub-group A1) were carried out by a single-layered, open technique and 20 (Sub-group A2) by a single-layered, closed, aseptic method. On Group B open anastomoses were performed in 13 (Sub-group B1) and the closed method was utilized in 100 (Sub-group B2). The patients were evenly distributed as to age, sex and type of pathology. Statistically significant differences were detected, favouring sub-groups A2 and B2 (closed anastomosis), as of major sepsis secondary to anastomotic leak ($p=0.05$, $p=0.001$, respectively), deaths consequent to it ($p=0.05$, $p=0.05$, respectively) and Combined sepsis ($p=0.001$, $p=0.001$, respectively). There were no wound infections on GROUP A. The wound infection rate, though higher in Sub-group B1 than in Sub-group B2 (15.3% vs. 5%) did not reach statistical value. It is concluded that the single-layered, closed anastomotic technique offers, indeed, a definite advantage over the more commonly used open method, not only decreasing the wound infection rate but, most effectively, in diminishing the incidence of major intraperitoneal sepsis, consequent to anastomotic leaks.

RESUMO

Anastomose num só plano por técnica fechada versus técnica aberta — Revisão de 35 casos esofágicos e 113 do colon

A ruptura anastomótica permanece o problema mais grave em cirurgia digestiva, muito em especial sempre que o esfago ou o colon e recto são partes interessadas. Numa tentativa de avaliar o papel desempenhado por duas técnicas diferentes, neste contexto, analisámos, retrospectivamente, 148 anastomoses (Janeiro 1973 - Setembro 1982), 35 envolvendo o esfago (GRUPO A) e 113 o segmento colo-rectal (GRUPO B). Quinze anastomoses do primeiro grupo (subgrupo A-1) foram executadas por uma técnica aberta e 20 por uma técnica fechada, aséptica (sub-grupo A-2). No segundo grupo o método aberto foi utilizado em 13 (sub-grupo B-1) e o fechado em 100 (sub-grupo B-2). Tanto numa modalidade como noutra as anastomoses foram num só plano. Os doentes estavam uniformemente distribuídos no que concerne a idade, sexo e tipo de patologia. Diferenças, estatisticamente significativas, foram detectadas, favorecendo os sub-grupos A-2 e B-2 (anastomose aséptica) no que diz respeito a sepsis *major* resultante da falência anastomótica ($p=0,05$, $p=0,001$, respectivamente), mortes directamente relacionadas com essa falência ($p=0,05$, $p=0,05$, respectivamente) e sepsis global ($p=0,001$, $p=0,001$, respectivamente). Não houve infecções da ferida operatória no grupo A. A incidência de feridas infectadas embora mais elevada no subgrupo B-1 do que no subgrupo B-2 (15,3% vs. 5%) não atingiu valor estatístico. Concluimos que a técnica de anastomose fechada, num só plano, oferece nítida vantagem sobre a, mais vulgarmente utilizada, técnica aberta, não apenas diminuindo o número de feridas infectadas, mas mais eficazmente, baixando a incidência de sepsis intraperitoneal *major*.

INTRODUCTION

A thorough, meticulous, anastomotic technique is the standard against which the expertise of any gastrointestinal surgical team has to be measured.¹ It remains, after all, the mainstay of abdominal surgical practice. A correctly performed anastomosis will end-up on a smooth, short, postope-

rative hospital stay, as opposed to a less than perfect one, allowing either frank or *sub-clinical* leaks, even though still leading to protracted, febrile, debilitating, expensive, hospital courses. It is no wonder, therefore, that a continuing quest for the *perfect* anastomosis remains as a major issue, which the staplers do not seem to have settled.^{2,3} Most gastrointestinal anastomoses will, eventually, heal,

TABLE 1 Esophageal Anastomoses (34 Esophagojejunostomies post Total Gastrectomy and 1 Esophagogastrotomy post Proximal Gastrectomy) — GROUP A (January 1973 - August 1982).

Data	OPEN TECHNIQUE Sub-group A1	CLOSED TECHNIQUE Sub-group A2	Statistical Signif.	Total
Number of pts	15	20	—	35
Male/Female	10/5	14/6	—	—
Mean age	56 (41-72)	55 (33-75)	—	55 (33-75)
Malignant Lesion	14	19	—	33
Benign Lesion	1	1	—	2
Wound Infect.	0	0	NS	0
Entero-cut. fistu.	1 (6.6 %)	0	NS	1 (2.8 %)
Anastom. leak, Major Sepsis	3 (20 %)	0	p=0.05	3 (8.5 %)
Death second. to leak	3 (20 %)	0	p=0.05	3 (8.5 %)
Combined Sepsis	4 (26.6 %)	0	p=0.001	4 (11.4 %)
Other causes of death	0	0	—	—
Overall Mortality	3 (20 %)	0	p=0.05	3 (8.5 %)

TABLE 2 113 Large Bowel Anastomoses (80 intraperitoneal, 33 totally or partially extraperitoneal).

Data	Open Method Subgroup B1	Closed Method Subgroup B2	Statistical Signif.	Total
Number	13	100	—	113
Male/Female	9/4	59/41	—	68/45
Mean Age	58 (35-68)	60 (12-79)	—	60 (12-79)
Malignant Lesion	10	71	—	81
Benign Lesion	3	29	—	32
Wound Infection	2 (15.3 %)	5 (5 %)	NS	7 (6.2 %)
Enterocut. Fistula	1 (7.7 %)	0	NS	1 (0.8 %)
Anast. Leak, Major Sepsis	3 (23.0 %)	4 (4 %)	p=0.001	7 (6.2 %)
Death second. to leak	2 (15.3 %)	3 (3 %)	p=0.05	5 (4.4 %)
Combined Sepsis	5 (38.5 %)	9 (9 %)	p=0.001	14 (12.3 %)
Other causes of death	0	2 (2 %)	NS	2 (1.7 %)
Overall Mortality	2 (15.3 %)	5 (5 %)	NS	7 (6.2 %)

provided a tension-free, well blood supplied and minimally traumatized cut edges, anastomosis is accomplished, to just mention universally accepted basic principles. There are areas, though, where some others, more sophisticated, technical refinements are, additionally, required if consistently undisturbed postoperative courses are to be expected. The esophageal⁴⁻⁶ and colon and rectal^{1, 7-9} segments are particularly prone to anastomotic leaks, the surgeon facing a rather marginal safety range whenever dealing within those areas. Sepsis remaining the major threat of digestive surgery,¹⁰ it has been found by us¹¹ that, after a Colo-rectal resection, the simple fact of constructing an anastomosis, as opposed to when this step is not required, will, significantly, increase the risk of bacterial complications. It seems, thereby, reasonable to assume that a *better* technique, when correctly applied on those areas might just represent the critical edge establishing the difference between success and failure. This study aimed to assess our experience with two modalities — Closed versus Open — of single-layered esophago-jejuno-gastric and ileo-colo-rectal anastomosis, in terms of immediate complications, directly related with the anastomotic technique.

PATIENTS, METHODS

From January 1973 till August 1982 the team led by the Senior Author (Lisbon University Hospital of Santa Maria — Surgery I) performed 35 Esophageal (Table 1, Group A, Sub-groups A1 and A2) and 113 Large Bowel (Table 2, Group B, Sub-groups B1 and B2) anastomoses, all of which single-layered of interrupted stitches, 120 of them utilizing a slight modification¹¹ of the Aseptic technique, originally described by DENNIS,¹² and 28 by an Open method, still singlelayered, as it is being applied in some centers,¹³ as opposed to the more popular and widely used two layers method. The cases were evenly distributed by both methods as of age, sex and pathology. No significant differences could be detected, as well, in what concerns factors, thought to be, in fact, predisposing to infection, after colectomy.^{11, 14} The only exception, concerning these factors, was that 14 (14 %) cases of Sub-group B2 did not undergo any bowel preparation (9 emergency resections plus 5 transverse colectomies in continuity with Gastric carcinoma resections), whilst only 1 (7.6 %) such case was included on Sub-group

B1. NICHOLS¹⁵ bowel preparation was carried down in all elective large bowel operations and systemic antibiotics (Aminoglycoside plus Clindamycin) were administered, intravenously, immediately prior to surgery and every 8 hours, for the ensuing 24-28 hours, thereafter, to all patients. The abdominal approach was through a midline incision in all patients, complemented by a separate right thoracotomy in 2 patients of Group A, the laparotomy closure technique being the same in all cases, as well. Drains, either intraperitoneal or on the subcutaneous tissue, were never left behind. All skin wounds were primarily closed. The overwhelming majority of anastomoses were carried out on an end-to-end fashion, the sole exceptions being 1 of sub-group A1, 5 of sub-group B2 and 1 of sub-group B1. A simultaneous *protective* colostomy was fashioned in one single instance, on a patient of sub-group B1, undergoing a low anterior resection with *en bloc* total removal of the urinary bladder and bilateral ureterosigmoidostomy. A decompressive colostomy had been done in 3 patients of sub-group B2 and in 1 of sub-group B1, left undisturbed at the stage of definitive resection and taken down later.

Frank anastomotic disruptions were, easily, detected by standard, clinical examination and confirmed either on relaparotomy or post-mortem examination. An enterocutaneous fistula was considered full evidence of partial anastomotic failure. The data, taken as proof of CONFIRMED leak, are tabulated on Table 3. Wound infections were defined according to standard criteria.¹⁶ Special emphasis was laid upon early detection of the so-called *sub-clinical* leaks, utilizing the means tabulated on Table 4. The esophageal (35, Group A, Table 1) and the low ileo-rectal or colo-rectal, either totally or partially extraperitoneal (29 on sub-group B2, 4 on sub-group B1), anastomoses were assessed by gastrographin

swallow or enema, respectively, and/or endoscopy, prior to the 10th-14th postoperative day, as practiced by GOLIGHER.⁷ Table 5 outlines the CONFIRMED leak rates observed among these leak-prone anastomoses, 19 by the open method and 49 utilizing DENNIS technique. A febrile course, with several peaks above 38 °C, not ascribable to respiratory or urinary tract infections or deep vein thrombosis, an inability to resume oral feedings and/or normal peristalsis and a persistently elevated WBC count (over 12 000/cc, shifted to the left), lasting for more than one week, after surgery, were interpreted as signs of intraperitoneal, perianastomotic, sepsis, secondary to SUSPECTED leaks (Table 4), though well confined, not requiring reexploration, merely delaying the debilitating postoperative course.

Six to 12 months, postoperatively, all patients available are submitted to barium swallow or enema and/or endoscopy for evaluation of the anastomotic caliber.

Statistical analysis was carried out utilizing the *Analysis of Variance* method, completed by SCHEFFE's multiple comparison method.

RESULTS

Data, concerning morbidity and mortality rates, directly related with the construction of an esophageal anastomosis (Group A), are summarized on Table 1. Statistically significant differences were noticed, favoring the closed method (Sub-group A2), as to the incidence of major sepsis, consequent to anastomotic failure, the rate of deaths secondary to it and the combined sepsis percentage. There were no deaths resulting from other causes in this Group A of patients. Much the same way, Table 2 (large bowel anastomo-

TABLE 3 CONFIRMED Anastomotic leaks, as proven by relaparotomy, autopsy, evidence of enterocutaneous fistula, X-ray and/or Endoscopy.

	Sub-group A1 n=15	Sub-group A2 n=20	Stat. sign.	Sub-group B1 n=13	Sub-group B2 n=100	Stat. sign.
Enterocut. Fistula	1 (6.6 %)	0	NS	1 (7.6 %)	0	NS
X-ray and/or Endosc.	2 (13.3 %)	0	NS	2 (15.3 %)	4 (4 %)	NS
Death secondary to Anastomotic leak	3 (20 %)	0	p=0.05	2 (15.3 %)	3 (3 %)	p=0.05
Total Leak Rate	4 (26.6 %)	0	p=0.001	3 (23 %)*	4 (4 %)**	p=0.001

* Two on Colo-rectal anastomoses, after Low Ant. Resect., one post L) Hemicol.

** Two on Colo-rectal anast., after Low Ant. Resect., one after emergency Total Colectomy, for massive bleeding, with Ileoproctostomy, one post R) Hemicolectomy.

TABLE 4 SUSPECTED Anastomotic Leaks, as judged from Clinical evaluation, X-Ray and/or Endoscopic studies.

	Sub-group A1 n=15	Sub-group A2 n=20	Stat. Sign.	Sub-group B1 n=13	Sub-group B2 n=100	Stat. Signific.
Febrile course, with peaks over 38 °C > 1 week	4 (26.6 %)	1 (5 %)	p=0.001	3 (23 %)	6 (6 %)	p=0.05
Need of N/G decompress. and I.V. fluids > 1 week	3 (20.0 %)	1 (5 %)	p=0.01	4 (30 %)	5 (5 %)	p=0.001
WBC count > 12 000 more than 1 week	4 (26.6 %)	1 (5 %)	p=0.001	4 (30 %)	5 (5 %)	p=0.001
Total suspected Leak Rate	4 (26.6 %)	1 (5 %)	p=0.001	4 (30 %)	5 (5 %)	p=0.001

TABLE 5 CONFIRMED Leaks, among 68 leak-prone anastomoses (see text).

	Open Technique		Closed Technique		Statis. Signif.
	N.º	Confirmed leaks (%)	N.º	Confirmed leaks (%)	
Esophageal	15	4 (26.6 %)	20	0	p = 0.001
Low Ileorectal	1	0	9	1 (11.1 %)	NS
Low Colorectal	3	2 (66.6 %)	20	2 (10 %)	NS
Total	19	6 (31.6 %)	49	3 (6.1 %)	p = 0.01

sis-Group B) puts into perspective the statistically significant differences, favoring the closed anastomosis technique (sub-group B2), regarding the same issues. Similarly, Tables 3 and 4 stress out the statistically significant advantage of the DENNIS^{11, 12} method on the incidence of CONFIRMED and SUSPECTED (see text) leak rates, which figures 1 and 2 try to emphasize. Perhaps more significantly, among 14 resections of *non prepared* (see text) large bowel, followed by aseptic anastomosis, there were no wound infections and only 1 patient went on to major sepsis and death, consequent to anastomotic leakage (this was on an emergency total colectomy, for massive bleeding on a 75 yrs. old man, with ileo-proctostomy, a gross technical error occurring while constructing the anastomosis), for a total sepsis rate of 7.1 %. The 5 % wound infection rate and 9 % combined sepsis incidence, noticed on our series of closed anastomosis (sub-group B2, Table 2) compares rather favorably, not only with our own series of open anastomosis (sub-group B1, Table 2), where a very small number of cases is included, but also with major published series^{14, 18-22} of open technique, both in prepared and non prepared bowels.

No laparotomy wound dehiscences occurred in any patient of both Groups A and B.

COMMENTS

Aware as we are of all criticisms which a retrospective evaluation is liable to, this study carries some features, not usually present in most retrospective analysis which, we believe, allow us to draw a few valid suggestions. The Senior Author (A.M.A.) was the sole responsible for the entire pre, intra and postoperative decision-making process, lending a rather uniform set of criteria to it. All patients were operated upon and taken care of within the same environment and by the same personnel.

Anastomosis breakdown is, still, the most dreaded complication of digestive Surgery. If a high percentage of success is to be expected, there should be no tension across the anastomosis, the bowel cut edges must be well blood supplied and minimally traumatized, the submucosa has to be included on the stitches,²³ the bowel serosal surfaces must be inverted and intimately apposed²⁴ and, MOST IMPORTANTLY, they should not be exposed to any soiling or, at least, a minimal one, by intestinal luminal contents, as it has been, experimentally, demonstrated.²⁵ Though the all time LEMBERT principle²⁴ has been challenged,²⁶⁻²⁹ further, both clinical and experimental, evidence, definitely, set out its obvious advantage over everting techniques. Whenever a surgeon is operating upon the rather mobile, pliable, well blood supplied, small bowel wall, a significantly wide margin is left for technical mishaps and inobservances of some of the, previously outlined, basic principles. The same

does not hold true, however, when an esophagojejunal, an ileo-rectal or a colorectal anastomosis are being carried down. It comes as no surprise, therefore, that the higher rates of leakage are, consistently, reported as occurring at these particularly challenging anatomical locations, namely immediately underneath the diaphragm or beyond the sacral promontory, the segments to be united remaining either totally or partially extraperitoneal. Several factors seem to concur to these undeniable realities: in both situations it is, technically, less easy to obtain a tension-free union, a thorough and lengthy dissection being necessary to achieve that goal, which, eventually, might reduce an already poor blood supply. In addition, there is no serosal covering and, consequently, no quick fibrin sealing, on the esophageal and rectal segments, respectively, where the stitches, having to be passed across longitudinal muscular strips, easily tear through, leaving behind minor, unnoticed, gaps, likely to initiate microabsces formation, eventually evolving on to full anastomotic disruption. The present series experience, in which 9, out of 11 CONFIRMED (Tables 3 and 5) anastomotic leaks, occurred on those, technically challenging, areas, seem to support our contention.

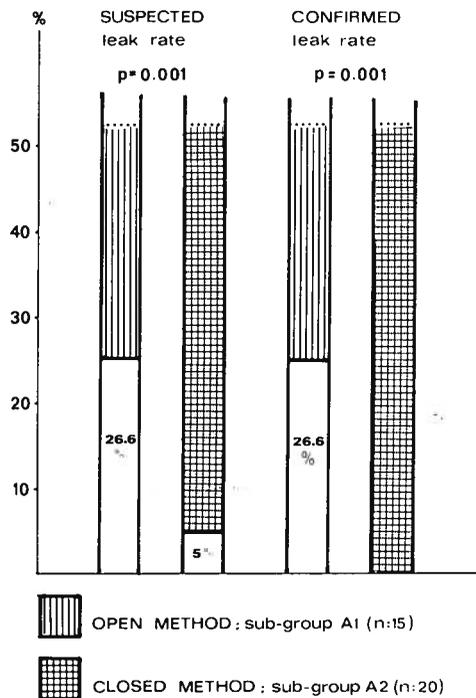


Figure 1: CONFIRMED and SUSPECTED (see text, Tables 3 and 4) leak rates among 35 Esophageal Anastomoses.

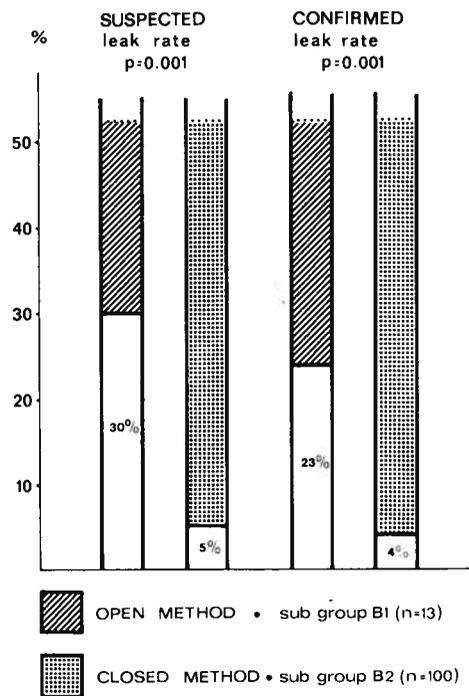


Figure 2: CONFIRMED and SUSPECTED (see text, Table 3 and 4) leak rates among 113 Large Bowel Anastomoses.

The remaining intraperitoneal large bowel wall though easier to manipulate and well protected by serosa still represents a leak-prone segment. In fact it has been shown^{8, 17} that an increased collagenase activity at this level might hinder the normal healing process. The abnormally elevated bacterial concentrations, both of aerobes and, in particular, anaerobes of the colonic contents, largely surpassing 10^6 /cc of pathogenic microorganisms,³² thought to be the minimal inoculum necessary to turn a simple contamination into a clinical infection, adds to the risk of spillage and subsequent infection, rendering an irreproachable technique an absolute *must*. Similar concentrations of bacteria have been demonstrated at the esophagogastric level, whenever gastric malignancy is the pathology involved,³³ as it is the case on the majority of esophageal anastomosis in this study (Table 1), constituting, in this area too, an additional risk factor. Since an extremely high percentage of anastomotic disruptions, both at the esophageal and large bowel levels, lead on to death, our experience merely confirming that of others,⁴⁻⁹ it becomes obvious that any anastomotic technical refinement, able to, significantly, decrease the number of dehiscences would cut down the death toll. Out of several studies, trying to compare the one-layer versus the two-layers open technique,³⁴⁻³⁶ it became apparent that the one-layer method seems to be followed by less anastomotic failures when applied below the peritoneal reflection, no definite advantage having been demonstrated when the intraperitoneal colon is involved. JONSELL and EDELMANN,¹³ however, having arrived at the same conclusion, strongly advocate the one-layer method in all large bowel anastomoses. The consistently better, statistically valid, results of present series (Table 1, 2, 3, 4 and Figures 1 and 2), obtained with the aseptic, closed method of constructing a single-layered anastomosis seem to suggest that this technical refinement might, indeed, add to the advantages of the one-layer method, decreasing not only the number of infected wounds but the anastomotic failure rate, as well. This fact becomes particu-

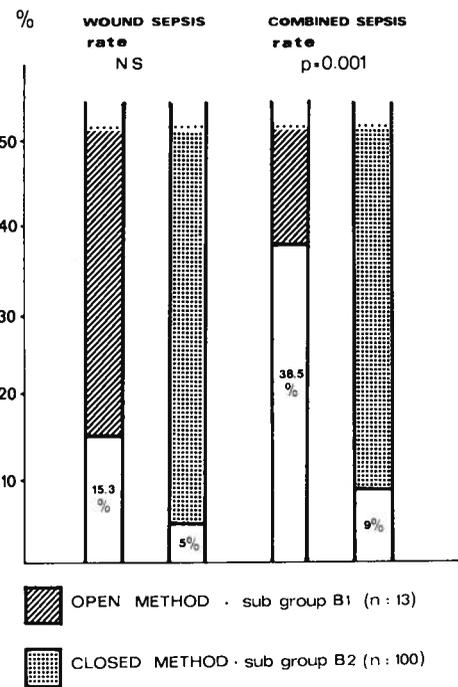


Figure 3: WOUND SEPSIS and COMBINED SEPSIS rates among 113 Large Bowel Anastomoses.

larly noticeable when those specially difficult and challenging anastomoses are, separately, evaluated (Table 5).

It might be argued that the main and only advantage of the closed method would be, merely, minimizing contamination during surgery and, therefore, decreasing the wound infection rate, without any significant role in diminishing post-surgery intestinal contents spillage, as compared to other techniques. Judging from this series experience (Figure 3), it appears that, though it does, indeed, decrease the wound infection rate, after colectomy, it plays an even more significant, statistically valid, role in decreasing major sepsis, secondary to anastomotic failure. NAHAI,²⁵ comparing clean anastomoses with those contaminated by faeces, has shown that intraluminal bacteria were of major importance on the peritoneal surface, at the suture line, leading to a higher rate of disruptions. These findings seem to lend experimental support to our clinical results. It can be surmised that it is easier to achieve a better, quicker and intimate invagination and apposition of the bowel wall surfaces with minimal or no soiling at all and, thereby, a better fibrin seal and better healing conditions, utilizing the DENNIS anastomotic method.

REFERENCES

1. KRUKOWSKI, Z. H. AND MATHESON, N. A.: Large Bowel Anastomosis. *Coloproctology*, 1981; 3: 161-165.
2. DUNN, D. H.; ROBBINS, P.; DECANINI, C. et al.: A comparison of stapled and handsewn colonic anastomosis. *Dis. Colon Rectum*, 1978; 21: 636-639.
3. REILING, R. B.; REILING, W. A.; BERNIE, W. A. et al.: Prospective, controlled, study of gastrointestinal stapled anastomosis. *Am. J. Surg.*, 1980; 139: 147-152.
4. SANCHEZ, R. E. AND GORDON, H. E.: Complications of Total gastrectomy. *Arch. Surg.*, 1970; 100: 136-139.

5. PAPACHRISTOU, D.; FORTNER, J.: Anastomotic failure complicating Total gastrectomy and Esophagogastrectomy for Cancer of the stomach. *Am. J. Surg.*, 1979; 138: 339-402.
6. WILSON, S. E.; STONE, R.; SCULLY, M. et al.: Modern management of anastomotic leak after esophagogastrectomy. *Am. J. Surg.* 1982; 144: 95-99.
7. GOLIGHER, J. C.; GRAHAM, N. G. and DEDOMBAL, F. T.: Anastomotic dehiscence after Anterior resection of Rectum and Sigmoid. *Br. J. Surg.*, 1970; 57: 109-118.
8. HAWLEY, P. R.; PAULK, W. P.; HUNT, T. K.; DUNPHY, J. E.: Collagenase activity in the Gastrointestinal tract. *Br. J. Surg.*, 1970; 57: 869-900.
9. SCHROCK, T. R.; DEVENNEY, C. W.; DUNPHY, J. E.: Factors contributing to leakage of Colonic anastomosis. *Ann. Surg.*, 1973; 177: 513-518.
10. GREENBURG, A. G.; SAIK, R. P.; FARRIS, J. M. and PESKIN, G. W.: Operative Mortality in General Surgery. *Am. J. Surg.*, 1982; 144: 22-26.
11. De ALMEIDA, A. S.; GRACIAS, W.; SANTOS, N. M. and ALDEIA, F. J.: Aseptic, singlelayer, anastomosis — Its possible role in minimizing Sepsis after Large Bowel surgery. *Coloproctology*; 1982; 4: 155-160.
12. DENNIS, C.: Oblique, aseptic, end-to-end iliac anastomosis. Procedure of choice in strangulation small bowel obstruction. *Surg. Gyn. Obst.*, 1943; 77: 225-242.
13. JONSELL, G. and EDELMAN, G.: Single layer anastomosis of the Colon — A review of 165 cases. *Am. J. Surg.*, 1978; 135: 630-632.
14. DEGENNARO, V. A.; CORMAN, M. L.; COLLER, J. A. et al.: Wound infections after Colectomy. *Dis. Colon Rectum*, 1978; 21: 567-572.
15. NICHOLS, R. L.; BROIDO, P.; CONDON, R. E. et al.: Effect of preoperative Neomycin Erythromycin intestinal preparation on the incidence of infectious complications following Colon surgery. *Ann. Surg.*, 1973; 178: 453-459.
16. CRUSE, P. J. E.: Wound infections: Epidemiology and clinical characteristics, chapter 20, page 431, Surgical Infections Diseases Textbook, Appleton-Century-Crofts, New York, Editors R. L. Simmons, R. J. Howard, 1982.
17. HAWLEY, P. R.: Causes and prevention of Colon anastomotic breakdown. *Dis. Colon Rectum*, 1973; 16: 272-277.
18. DOWNING, R.; MCLEISH, A. R.; BURDON, D. W.; ALEXANDER-WILLIAMS, J.; KEIGHLEY, M. R. B.: Duration of systemic, prophylactic, antibiotic cover against anaerobic sepsis in intestinal surgery. *Dis. Colon Rectum*, 1977; 20: 401.
19. SLAMA, T. G.; CAREY, L. C.; FASS, R. J.: Comparative efficacy of prophylactic cephalotin and cephmandole for elective colon surgery: Results of a doubleblind, randomized, prospective study. *Am. J. Surg.*, 1979; 137: 593-596.
20. COHN, Jr. I.: Intestinal Antisepsis. *Surg. Gyn. Obst.*, 1970; 130: 1006-1014.
21. HERTER, F. P. and SLANETZ, Jr. C. A.: Influence of antibiotic preparation of the bowel in complications after colon resection. *Am. J. Surg.*, 1967; 113: 165-170.
22. AZAR, H.; DRAPANAS, T.: Relationship of antibiotics to wound infection and enterocolitis in colon surgery. *Am. J. Surg.*, 1968; 115: 209-215.
23. HALSTED, W. S.: Circular suture of the intestine — An experimental study. *Am. J. Med. Sciences*, 1887; 94: 436-461.
24. LEMBART, A.: Memoir sur l'enterorrhaphie. *Rep. Gen. d'Anat. Physiol. Pathol.*: 1826; 11: 101.
25. NAHAI, F.; LAM, J. M.; HAVICAN, R. G.; STONE, H. H.: Factors involved in disruption of intestinal anastomosis. *Am. Surg.* 1977; 43: 45-51.
26. GETZEN, L. C.: Clinical use of everted intestinal anastomosis. *Surg. Gyn. Obst.*, 1966; 123: 1027.
27. GETZEN, L. C.; ROE, R. D. and HOLLOWAY, C. I.: Comparative study of intestinal anastomotic healing in inverted and everted closures. *Surg. Gyn. Obst.*, 1966; 123: 1219.
28. RAVITCH, M.; RIVAROLA, A. and VANGROV, J.: Studies in intestinal healing. I. Preliminary studies of the mechanism of healing of the everting intestinal anastomosis. *Johns Hopkins M. Surg. J.*, 1967; 121: 343.
29. RAVITCH, M.; CANALIS, F.; WEINSELBAUM, A. and McCORMICK, J.: Studies in Intestinal healing. III. Observations on everting Intestinal anastomosis. *Ann. Surg.*, 1967; 166: 670-677.
30. GOLIGHER, J. C.; MORRIS, C.; McADAM, W. A. F.; DE DOMBAL, F. T. and JOHNSTON, D.: A controlled trial of Inverting versus Everting Intestinal suture in Clinical Large Bowel surgery. *Br. J. Surg.*, 1970; 57: 817-822.
31. RUSCA, J. A.; BORNSIDE, G. H.; COHN, Jr. I.: Everting versus Inverting gastrointestinal anastomosis — Bacterial leakage and anastomotic disruption. *Ann. Surg.*, 1969; 169: 727-734.
32. ARABI, Y.; DIMOCK, F.; BURDON, D. W.; ALEXANDER-WILLIAMS, J. and KEIGHLEY, M. R. B.: Influence of bowel preparation and antimicrobials on colonic microflora. *Br. J. Surg.*, 1978; 65: 555-559.
33. GATEHOUSE, D.; DIMOCK, F.; BURDON, D. W.; ALEXANDER-WILLIAMS, J. and KEIGHLEY, M. R. B.: Prediction of wound sepsis following gastric operations. *Br. J. Surg.*, 1978; 65: 551-554.
34. McADAMS, A. J.; MEIKLE, A. G. and TAYLOR, J. O.: One layer or Two layer Colonic Anastomosis. *Am. J. Surg.*, 1970; 120: 546-549.
35. IRVIN, T. T.; GOLIGHER, J. C. and JOHNSTON, D.: A randomized, prospective, clinical trial of single-layer and two-layer inverting intestinal anastomosis. *Br. J. Surg.*, 1973; 60: 457-460.
36. EVERETT, W. G.: A comparison of one layer and two-layer techniques for Colorectal anastomosis. *Br. J. Surg.*, 1975; 62: 135-140.

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