Bowel anastomosis

A comparative study of various surgical techniques

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ABSTRACT

Objectives: Mechanical suture (stapler) has been in use for bowel anastomosis since the second half of the 20th century, however, it became popular since it was used widely by the United States of America in the late 1960. Since it is more expensive than the conventional method, a local experimental assessment was introduced to compare stapler with conventional methods.

Methods: Eighteen local dogs were used, 36 anastomosis were assessed in the animal house operating theater of King Khalid University Hospital, Riyadh, Kingdom of Saudi Arabia between October 1998 and March 2000.

Results: The weight needed to disrupt the anastomosis was more in the stapler technique, the amount of intraperitoneal fluid, adhesion and the inflammatory response in histopathological study were less in the stapler technique. Our study has shown that the stapler technique is superior when compared with conventional bowel anastomosis.

Conclusion: We recommend stapler use in bowel anastomosis whenever clinically feasible.

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The introduction of mechanical sutures (stapler) for bowel anastomosis in King Khalid University Hospital, Riyadh, Kingdom of Saudi Arabia has raised a question whether is it worth to spend so much of money on this technique? Do we have convincing data to keep on using it? These questions led to perform this experimental study to compare stapler and other conventional techniques of bowel anastomosis.

Methods. A local breed of dogs with an average weight of 20 kgs were used. Eighteen dogs were chosen and examined by Veterinary Surgeon and kept under his supervision in the animal house on a staple diet of canned dog food. The 18 dogs were arranged into 3 groups, and all had their small bowel divided into 2 levels. Fifteen cm apart, the divided ends being anastomosed with chromic catgut (group A): braided silk (group B), and mechanical suture (group C).

Preparation of the animal for surgery. Two days prior to surgery, the chosen dog was placed in an isolated cage, 12 hours before surgery the food was withdrawn, but water was given ad libitum through the automatic water system circulating throughout the animal house. In all animals, anesthesia was induced by intravenous pentobarbital 30mg/kg. Followed by tracheal intubation and was maintained with oxygen, nitrous oxide and halothane. The abdominal wall was shaved using an electric shaver.

Surgical procedure. Standard aseptic technique was observed. The skin was cleansed by savlon solution and a sterile towels were used keeping only

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the area of incision exposed. Through a mid-line incision, the ileum was isolated from surrounding abdominal structures using standard abdominal pack to avoid contamination. At the mid-ileum region 2 divisions were made 15 cm apart from each other. In group A (6 dogs) chromic catgut was used for the 2 anastomosis. Continuous suture was used in 3 dogs (A1) and the remaining 3 dogs underwent an interrupted chromic catgut anastomotic (A2). In group B, braided silk was used for continuous suture technique in 3 dogs (B1) and an interrupted suture technique in the other 3 dogs (B2). In group C, (6 dogs), a triangular anastomosis at 2 levels was carried out by using TA30 (auto-suture) (**Figure 1**). The abdominal wall was closed into 2 layers, the peritoneum and linea allea were closed by chromic catgut and the skin was closed by black silk.

Post-operative course. The dogs were allowed to recover from anesthesia before it was taken to the cage. During the first 36 hours after surgery, the dogs were offered milk and bread. After this period the diet was changed to normal canned dog food. Eight days postoperatively, the animals were re-anesthetized; abdominal skin stitches were removed and the same mid-line incision reopened. The following criteria were noted and recorded: 1) Peritoneum inspected for fluid and adhesion 2) Site of anastomosis identified 3) Adhesion with other bowel loop or omentum were recorded. A piece of ileum was excised 7-8 cm proximal to the 1st anastomosis and distal to the 2nd anastomosis. Re-anastomosis of the bowel were performed using chromic catgut and abdominal wall was closed in the same way as mentioned before. All dogs have made uneventful recovery.

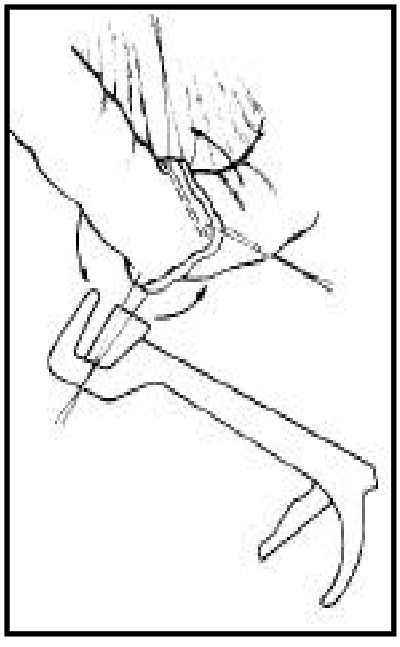

Figure 1 - Showing the bowel anastomoses in triangular fashion.

Testing the strength of the anastomosis. The excised piece of ileum was divided in the middle so each piece contain one anastomosis. Each piece of ileum was divided longitudinally into 2 equal pieces. One end was fixed and the other was left hanging and to this end a basket of weight was applied, the weight being gradually increased until the anastomosis was disrupted.

Statistical analysis. Statistical Package for Social Sciences (SPSS) software was used for data analysis and tabulation. Range, mean and standard deviation were used to analyze the present data. Comparison between all groups was performed using analysis of variance (ANOVA). Post hoc comparisons were applied using Scheffe's method.

Results. While the weight needed to break the anastomosis in group A1 weight ranged between 410-695 gms, in group A2 between 500-745 gms, in group B1 between 650-910 gms, group B2 between 810-1210 gms and in group C between 920-1400 gms (**Table 1**). The histopathological study of the inflammatory process and the collagen fibres formation was performed for the 3 group A, B and C (**Figures 2, 3 & 4**). In our experience the following observations were noted: 1) The amount of intra-peritoneal fluid seen at the 2nd laparotomy was less in case of stapler group C than seen in group A and B. 2) The amount of adhesion between the site of anastomosis, other bowel's loop, the omentum and parietal peritoneum were less in group C compared with group A and B. 3) The inflammatory process was less in group C than those in group A and B.

Table 1 - Distribution of weights in grams required to break anastomosis according to anastomosis type.

Suture	**n of anastomoses**	**Mean weight in gms ± SD (range)**
Catgut continuous	6	610 ± 125.1 (410 - 695)
Catgut interrupted	6	680 ± 94.3 (500 - 745)
Silk continuous	6	830 ± 115.2 (650 -910)
Silk interrupted	6	1054.2 ± 159.9 (810 -1210)
Steel staples	12	1133.3 ± 163 (920 -1400)
Total	**36**	**906.9 ± 252.3 (410 - 1400)**

p<0.001, n - number, SD -standard deviation, gms - grams

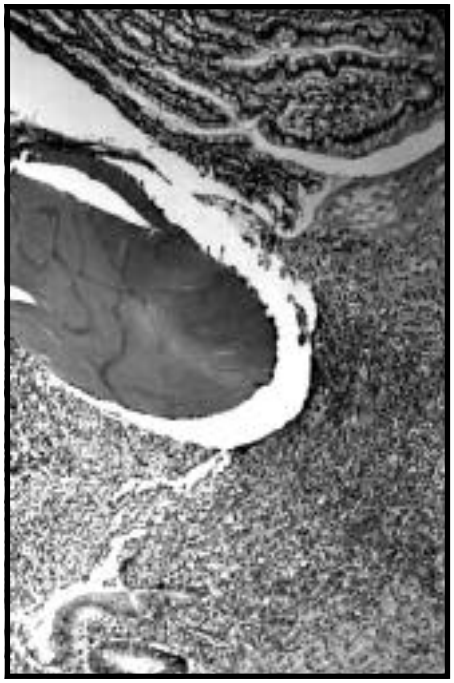

Figure 2

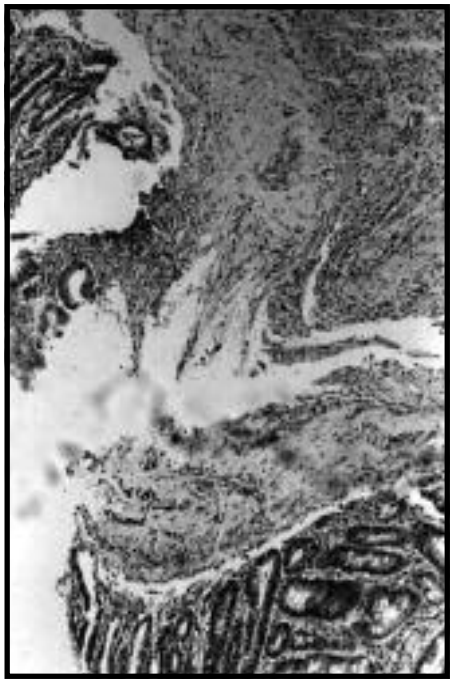

Figure 4

Figure 3

Figure 2 - Showing histological section using catgut suture: Healing area showing granulation tissue formation and a dense inflammatory cell infiltrate predominantly polymorphonuclear leukocytes surrounding retained piece of catgut suture materials.

Figure 3 - Showing histological section using silk suture: Healing area showing granulation tissue formation and moderate inflammatory cell infiltrate surrounding retained suture materials.

Figure 4 - Showing histological section using auto suture: Healing area showing mature granulation tissue with collagen deposition associated with minimal inflammatory cell infiltrate.

Table 2 - Multiple comparisons between mean weights acquired to break anastomosis.

Procedure I	Procedure J	Mean difference I-J	SE	Sig.	95% confidence interval	
					Lower bound	Upper bound
Catgut continuous	Catgut interrupt	-70	80.95	0.943	-334.96	194.96
	Silk continuous	-220.83	80.95	0.142	-485.80	44.13
	Silk interrupt	-444.17*	80.95	0.000	-709.13	-179.20
	Steel staples	-523.33*	70.10	0.000	-752.80	-293.87
Catgut interrupt	Catgut interrupt	70	80.95	0.943	-194.96	334.96
	Silk continuous	-150.83	80.95	0.494	-415.80	114.13
	Silk interrupt	-374.17*	80.95	0.002	-639.13	-109.20
	Steel staples	-453.33*	70.10	0.000	-683.80	-223.87
Silk continuous	Catgut interrupt	220.83	80.95	0.142	-44.13	485.80
	Silk continuous	150.83	80.95	0.494	-114.13	415.80
	Silk interrupt	-223.33	80.95	0.135	-488.30	41.63
	Steel staples	-302.50*	70.10	0.005	-531.96	-73.04
Silk interrupt	Catgut interrupt	444.17*	80.95	0.000	179.20	709.13
	Silk continuous	374.17*	80.95	0.002	109.20	639.13
	Silk interrupt	223.33	80.95	0.135	-41.63	488.30
	Steel staples	-79.17	70.10	0.863	-308.63	150.30
Steel staples	Catgut interrupt	523.33*	70.10	0.000	203.87	752.80
	Silk continuous	453.33*	70.10	0.000	223.87	682.80
	Silk interrupt	302.50*	70.10	0.005	73.04	531.96
	Steel staples	79.17	70.10	0.863	-150.30	308.63

Procedure I - stands for catgut continuous, catgut interrupt, silk continuous, silk interrupt, steel staples. Procedure J - comparison between one suture from Procedure I to 4 sutures. * The mean difference is significant at 0.05 level, SE - standard error, Sig. - significant, inborn

Therefore, using stapler would help to minimize the subsequent complication of adhesions formation following bowel anastomosis and produced significantly better tensile strength as demonstrated in **Table 1**.

Discussion. The use of stapler have gained popularity since they were introduced in the United States of America in the late 1960, when the conventional technique of bowel anastomosis was compared with the stapling technique this made no significant difference in mortality and morbidity.[1,4] Nevertheless, stapler technique has the advantage of enhancing the blood flow across the anastomosis,[2] causes less tissue trauma, necrosis, causing less anastomotic edema[3] and reduced operating time. While the weight needed to disrupt the anastomosis was the least in group A (410 gms), and group C was the heaviest (1400 gms). The overall differences between means is considered to be statistically significant ($p<0.001$). When tensile strength of the anastomosis was considered, the stapler group proved to be stronger. Multiple comparison between mean (**Table 2**) shows that steel staples is significantly stronger anastomosis than the catgut and continuous silk sutures groups ($p<0.01$). Interrupted silk suture anastomosis is significantly stronger than catgut sutures ($p<0.01$). Concerning the same material of sutures regardless of method of suturing, there was no statistical significant difference detected between continuous and interrupted procedures ($p>0.05$). Our experience seems to go in line with the observation made by Ravitch[5] in his experimental and clinical work on bowel anastomosis.

In conclusion, the mechanical suture (stapler) is superior when compared with the conventional bowel anastomosis technique. Accordingly, whenever it is clinically feasible, we recommend it to be used for bowel anastomosis.

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