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Skin Stapled Bowel Anastomosis in a Canine Model

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ABSTRACT

Aim of Study: The aim of this study is to compare the safety and cost effectiveness of the use of staples designed for skin closure in the construction of colonic anastomoses.

Method: Twenty healthy dogs were prospectively randomised to either skin stapled or sutured anastomosis. The ascending colon was transected and reanastomosed. This segment was excised and used to test early bursting strength. There was no significant difference between the two groups. The ends of the colon were reanastomosed.

Results: The time taken to perform the anastomosis and the cost of the suture or staples were noted. The time taken for the stapled anastomosis was significantly faster ($p < 0.001$) with a mean of 7.95 minutes versus a mean of 23.5 minutes for the handsewn anastomosis. The cost was also significantly less ($p = 0.18$) with a mean of SGD17.85 compared to a mean of SGD21.15 for the handsewn anastomosis. Two weeks later, the dogs were sacrificed and the late bursting pressures were tested and no significant difference was found between the two groups. The anastomotic site was then sent for histological examination. The four animals, one in the handsewn group and 3 in the skin stapled group, dying prior to sacrifice, were subjected to post-mortem.

Conclusion: The results show that skin stapled anastomoses are easy to learn and perform and may constitute a viable alternative to hand suture techniques.

Keywords: skin staples, bowel anastomosis

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INTRODUCTION

The safety and ease of use of conventional bowel staplers are well established. They have the advantage of being convenient especially in areas where access is difficult eg. in the pelvis. The one very important drawback is the high cost of the stapling devices.

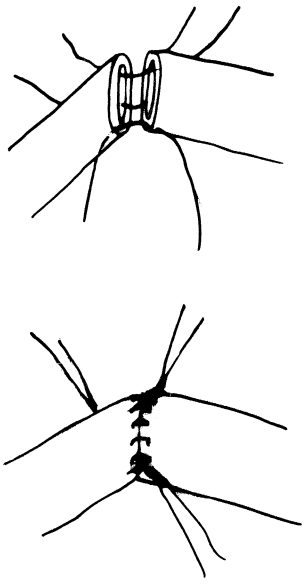
The idea to use skin staples[1-3] to perform bowel anastomoses is attractive in that it represents time and cost savings. However, unfamiliarity with the technique and concerns with safety have prevented their widespread application. We undertook an animal study to evaluate the safety of skin staples in the creation of bowel anastomoses.

METHOD

Twenty healthy dogs were prospectively randomised to either skin stapled or sutured anastomosis. The dogs had no bowel preparation. They were placed under general anaesthesia and the abdomen was entered through a midline incision.

A segment of the ascending colon was located and transected. The ends were reanastomosed either using skin staples or a single layer interrupted serosal-submucosal technique with 3/0 polyglycolic acid. The anastomoses were performed without the use of clamps (Fig 1).

In the skin stapled group, stay sutures of 3/0 polyglycolic acid were used to triangulate the lumen and to create inversion of the suture line before the skin staples were applied (Fig 2).



Initial bursting pressures

Immediately after anastomosis, the colon segment around the anastomosis was mobilised, resected and tested for early bursting pressure. The colon ends were then reanastomised and the abdomen closed. The time taken to perform each anastomosis and the cost of the suture or staples was noted.

The resected segment was used to test early bursting pressure using a hydrostatic model. One end of the bowel was tied off. The other end was tied around intravenous tubing connected to a bag of saline dyed with methylene blue and primed to exclude

air bubbles. The bag was then raised along a tape measure and the level of the saline was measured until leakage was noted by escape of the dye. The pressure required to burst the bowel was measured in centimetres of water. This method was considered to be more representative of normal physiology than a tensiometry method. Plain white gauze was laid around the anastomotic site and any gross defects in the anastomosis would manifest by leakage of fluid. This method is similar to that described by Gilbert and Trapnell[4].

Late bursting pressures

Two weeks later, the dogs were sacrificed and the bursting pressures were similarly tested. The anastomotic site was then sent for histological examination to determine the quality of healing and the extent of foreign body reaction. Animals dying prior to sacrifice were subjected to post-mortem to determine the cause of death.

Statistical analysis was performed using the Student t-test on an IBM compatible computer utilising a Windows based SPSS (Statistical Product and Service Solutions) programme.

RESULTS

From the study we derived 10 values for initial bursting pressures (Table II) on each of the sutured and stapled arms. The mean initial bursting pressure for the sutured anastomosis is 75.3 cm of H_20 (range 30 – 200). For the skin stapled anastomosis group, the mean bursting pressure was 109 cm of H_20 with a range of 30 – 240 cm of water.

The mean of the late bursting pressure for the hand sutured group is 120 cm of water with a range of 120 – 240 cm of water. For the skin stapled group, the mean late bursting pressure was 184.3 cm of water with a range of 30 – 240 cm of water (Table III).

There was one death in the hand sutured anastomosis group which occurred a week post-operatively. Three animals in the skin stapled anastomosis group who were in the first half of the experiment also died resulting in 9 values of late bursting pressures for the sutured group and seven for the anastomotic group. All deaths were related to leaks in the anastomosis (Table IV).

The mean time taken (Table I) for effecting the anastomosis in the sutured group was 23.4 mins with a range of 18 – 30 mins. As for the skin stapled group, there was significant time saving with a mean of 7.95 mins and a range of 4 – 10 mins.

The cost of the anastomosis (Table IV) was worked out based on the number of lengths of polyglycolic acid used and the number of staplers required. The mean cost for the hand sutured anastomosis was SGD21.15 using between 4 to 9 lengths of polyglycolic acid with a range between SGD17.50 to SGD31.50. The cost for the stapled anastomosis includes the lengths of polyglycolic acid used as stay sutures to triangulate the lumen. Skin stapled anastomosis costs an average of SGD17.85 with a range of SGD17.50 – SGD21.00. Although the number of staples applied varied, but not more than 35 in one stapler was necessary. These savings were found to be significant.

In our analysis, except for the time taken which was much faster in the skin stapled anastomosis group, the differences were not found to be statistically significant.

The resected anastomoses were sent for histological examination. Sections of the intestine anastomosed by suture showed chronic inflammation and fibrosis in the submucosa and muscularis propria. There was a marked multinucleate giant cell and histiocytic reaction to the suture material in the wall and surrounding fat as well as marked inflammation and fibrosis in the serosa and mesenteric fat. In contrast, histologic sections from the intestine anastomosed by skin staples showed a less florid chronic inflammatory response and less fibrosis in the wall. There was little to no multinucleate giant cell and histocytic response seen around the metal staples.

With regards to morbidity (Table V), there was one case of wound dehiscence with a small gap in the wound, one case of wound infection and 4 cases of burst abdomen related to leaks. One case of scrotal abscess and 2 cases of sealed off perforations in the skin stapled group in which the dogs were clinically well but late bursting pressures were as expected, very low at 30 cm and 60 cm water.

Table I – Results: time taken (in minutes)

	mean	range
Handsewn anastomoses (n = 20)	23.5	(15 – 32)
Skin stapled anastomoses (n = 20)	7.95	(4 – 10)
$p < 0.001$		

Table II – Results: initial bursting pressure (cm water)

	mean	range
Handsewn anastomoses (n = 10)	75.3	30 – 200
Skin stapled anastomoses (n = 10)	109	30 – 240
$p = 0.409$ (< 0.05)		

Table III – Results: late bursting pressure (cm water)

	mean	range
Handsewn anastomoses (n = 9)	235	200 – 24
Skin stapled anastomoses (n = 7)	184	30 – 240
$p = 0.207$ ($p > 0.05$)		

Table IV – Results: cost (Singapore dollars)

	mean	range
Handsewn anastomoses (n = 20)	21.15	21 – 31.5
Skin stapled anastomoses (n = 20)	17.85	17.5 – 21
$p = 0.18$ (< 0.05)		

Table V – Mortality and morbidity

	no.	leaks/ deaths	wound dehiscence	other complications
Handsewn	10	1	2	1 wound infection
Skin stapled	10	3	2	1 scrotal abscess

DISCUSSION

Intestinal suturing is one of the frequent operative steps and controversy that still exists over the appropriateness of various techniques and the use of various sutures. The intestinal suture line has special importance in that there is powerful movement of peristalsis across it, yet the healing wound must not leak or contract.

The use of conventional staplers is a safe, effective and time saving method in bowel anastomosis but is very costly especially if more than one anastomosis is to be performed.

The use of skin staples in bowel anastomosis is a novel concept which was first presented by Fackler[5], where he successfully used skin staplers in small bowel anastomoses in pigs. His findings has much merit in its ease of use, speed of anastomosis and cost savings.

The present study shows that the freshly completed skin stapled anastomosis is at least as strong, if not stronger than that of the hand sutured anastomosis in having a higher mean bursting pressure. Both mean pressures were above 25 cm of water pressure, which Gilbert and Trapnell considered, the threshold below which the anastomosis is likely to leak.

However, the leak rate was higher in the skin stapled anastomosis group. This is probably due to initial unfamilarity with the technique, as all the deaths occurred in the first half of the study. Skin stapled anastomosis is easy to learn but requires close attention to certain details of techniques such as the careful placement of the stay sutures to triangulate the bowel lumen as well as to invert the suture line. The staples also have to be placed very closely together, more so than with conventional sutures. Staples are not innately haemostatic and attention should be given to hemostasis prior to anastomosis. In this study when the anastomosis did heal, there was no significant difference in the late mean bursting pressures.

The hand sutured anastomosis took almost three times as long to construct as the skin stapled anastomosis, and cost was the same or more. Time savings would be multiplied especially in a case of multiple anastomosis as may occur in polytrauma where speed is of the essence in an unstable patient[1].

Two papers from Wiltshire, Howell and Wetherall et al[1,3] had similar findings in pigs. Both papers showed that the stapled technique was consistently faster than the handsewn methods and there was no compromise of integrity of the anastomosis with skin staple use nor were there any features identified on histology to indicate impaired healing with the staple method.

Another point to note is that during post-mortem of the dogs in our study, there was minimal peritoneal reaction to exposed staples and no significant differences were noted in the degree of adhesions present.

CONCLUSION

The safety of skin staples for bowel anastomoses is not established in our study and we would advise caution. This technique is shown to be useful and merits further study and trials especially with regard to the development of staples specifically for this purpose. The technique is consistently faster than handsewn anastomoses and easier to master for the junior surgeon.

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