

CLINICAL RESEARCH

Clinical outcomes of the use of unidirectional barbed sutures in gastrointestinal surgery for dogs and cats: A retrospective study

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Abstract

Objective: To report the clinical outcomes of gastrointestinal surgery using unidirectional barbed sutures in single-layer appositional closure in dogs and cats.

Study design: Retrospective and descriptive study.

Sample population: Twenty-six client-owned dogs; three client-owned cats.

Methods: Medical records of dogs and cats that received gastrointestinal surgery closed with unidirectional barbed sutures were reviewed to collect information on signalment, physical examinations, diagnostics, surgical procedures, and complications. Short- and long-term follow-up information was collected from the medical records, the owners, or the referring veterinarians.

Results: Six gastrotomies, 21 enterotomies, and nine enterectomies were closed with a simple continuous pattern with unidirectional barbed glycomer 631 sutures. Nine dogs had multiple surgical sites closed with unidirectional barbed sutures. None of the cases in the study developed leakage, dehiscence, or septic peritonitis during the 14-day short-term follow up. Long-term follow up information was collected for 19 patients. The median long-term follow-up time was 1076 days (range: 20–2179 days). Two dogs had intestinal obstruction due to strictures at the surgical site 20 and 27 days after surgery. Both were resolved with an enterectomy of the original surgical site.

Conclusion: Unidirectional barbed suture was not associated with a risk of leakage or dehiscence after gastrointestinal surgery in dogs and cats. However, strictures may develop in the long term.

Clinical significance: Unidirectional barbed sutures can be used during gastrointestinal surgery in client-owned dogs and cats. Further investigation of the role of unidirectional barbed sutures leading to abscess, fibrosis, or stricture is necessary.

1 | INTRODUCTION

Gastrointestinal surgery in small animals is very common.¹ Gastrointestinal obstruction with foreign material is the most common indication for a gastrotomy, an enterotomy,

an enterectomy, or a combination of those procedures. Those surgeries are traditionally performed with conventional absorbable sutures.^{1,2} The most devastating complication of full-thickness gastrointestinal surgery is incisional dehiscence resulting in septic peritonitis.

Surgical techniques have been improved, leading to decreased risk of leakage and dehiscence, and risk factors have been identified for a more informed case prognosis in the postoperative period.^{3–8} In the last decade, stapling equipment has been used with or without oversewing the staple line to accomplish a side-to-side anastomosis of the intestine.^{9–14} Stapling equipment has been associated with lower rates of postoperative dehiscence, and lower rates of dehiscence when septic peritonitis is present before surgery.¹¹

Unidirectional barbed sutures are self-anchoring sutures that do not require knot tying at the end of any simple continuous pattern. These sutures have mostly been used during minimally invasive surgery in humans and dogs.^{15–25} Bautista et al.²⁵ reported the successful utilization of unidirectional barbed sutures during laparoscopic gastrointestinal surgeries in 50 human patients with a 1.6% rate of postoperative leakage on 62 anastomotic sites. In an *ex vivo* study using a canine cadaveric intestine, a higher leakage pressure after enterectomy occurred when compared with a traditional smooth suture.²⁶ Ehrhart et al.²⁷ have demonstrated that unidirectional barbed sutures were not associated with an increased risk of leakage and dehiscence in the intestine of dogs without pathology present. Unidirectional barbed sutures have been shown to reduce surgical and anesthesia time and have no knot-related complications.^{28–31}

The purpose of this study is to report the clinical outcome of gastrointestinal surgeries completed with unidirectional barbed sutures for client-owned dogs and cats.

2 | MATERIALS AND METHODS

Medical records of dogs and cats that were presented at the Colorado State University Veterinary Teaching Hospital for gastrointestinal surgery from 2015 to 2021 were reviewed. The inclusion criteria were the usage of unidirectional barbed sutures to close one or more gastrointestinal surgery sites in a client-owned dog or cat.

Information collected from each animal's records included age, breed, sex, presenting complaint, physical examination on presentation, surgical procedures performed, surgical location, gastrointestinal perforation identified intraoperatively, suture type and pattern used, duration of hospitalization, short-term complications (incisional dehiscence, infection, seroma formation, illness due to septic peritonitis), and long-term complications (septic peritonitis, adhesion, stricture, abscessation). For any situations in which revision surgery was necessary, the section of the bowel that had been removed was submitted for histopathology.

Follow-up information was collected from the medical records, the owners, or the referring veterinarians.

Short-term complications were defined as complications occurring within 14 days after surgery. Long-term complications were defined as any complications occurring after 14 days. The short-term and long-term complications recorded were only complications related to gastrointestinal surgery. Short-term complications associated with the gastrointestinal surgery included the development of septic peritonitis related to either leakage or dehiscence of the surgical site. Septic peritonitis had to be confirmed with cytology and or biochemistry on the abdominal fluid collected by abdominocentesis. Vomiting, diarrhea, tachycardia, and tachypnea were also recorded, however they were not necessarily related to the gastrointestinal surgery if septic peritonitis did not develop. Surgical site complications were also recorded. Long-term complications included any complications (obstruction, other foreign body located at the previous surgical site) related to the previous gastrointestinal surgery. If any procedures other than gastrointestinal surgery were performed during the initial surgery, complications related to those other procedures were not recorded in the short or long term.

Descriptive statistics are used to describe the population and report outcomes. Data are presented as median and range.

3 | RESULTS

Twenty-six dogs and three cats met the entry criteria. The same board-certified surgeon performed all the surgeries. The median age of the dogs was 4 years (range: 0.6–13.5 years) and 1 year for the cats (range: 0.5–1 years). The canine population included nine spayed females, one intact female, two intact males, and 13 castrated male dogs. In the study population there were four mixed-breed dogs, three Labrador retrievers, and one of each of the following breeds: American pit bull terrier, Australian heeler, Bernese mountain dog, border collie, bloodhound, boxer, Cavalier King Charles Spaniel, coonhound, corgi, Doberman pinscher, English bulldog, German shorthair pointer, Golden retriever, Irish setter, husky, mastiff, Chinese shar-pei, and shih tzu. The feline population comprised two female spayed domestic short hairs, and one male castrated sphinx.

Clinical signs at the time of presentation included anorexia and vomiting in all three cats, with one showing lethargy. Twenty-one dogs presented with vomiting, 15 with anorexia, and six with diarrhea. Abdominal radiographs, abdominal ultrasounds, or both were used to determine indications for gastrointestinal surgery.

Dogs underwent surgery for a gastric foreign body (1), intestinal foreign body (15), gastric and intestinal foreign

TABLE 1 Distribution of surgical procedures performed with unidirectional barbed sutures.

Procedures	Dogs	Cats
Enterotomy	19	2
Enterectomy	9	0
Gastrotomy	5	1

bodies (7), intestinal mass (1), adhesion secondary to a mesenteric abscess (1), intestinal mesenteric volvulus with ischemia limited to one loop of the jejunum (1), and small intestinal dysmotility with biopsy of the jejunum (1). Three cats underwent surgery for foreign body obstruction. The foreign body was linear in six dogs and one cat. Two dogs had mild septic peritonitis due to the identification of perforation at the time of surgery. The surgeries were performed laparoscopically, assisted in six cases (one cat and five dogs), and with midline laparotomy in 22 cases. One dog had an extrahepatic portosystemic shunt, attenuated at the time of gastrotomy for a foreign body.

The distribution of the procedures that were performed with unidirectional barbed sutures in dogs and cats is reported in Table 1. Four additional gastrotomy procedures in our animal population were closed with a simple continuous suture pattern with 4-0 glycomer 631 (Biosyn, Medtronic, Minneapolis). Gastrointestinal surgeries were performed at multiple sites on nine dogs. A 4-0 unidirectional barbed glycomer 631 (VLoc 90, Medtronic, Minneapolis) was used for 19 enterotomies, five gastrotomies, and nine enterectomies. Two enterotomies and one gastrotomy were performed using 2-0 unidirectional barbed glycomer 631s (VLoc 90). When unidirectional barbed sutures were used for a gastrotomy or an enterotomy, a simple continuous suture pattern was started before the incision, and it was anchored by introducing the needle through the loop. The continuous suture pattern was completed past the end of the incision with two extra stitches at 180° as recommended by the manufacturer. When an enterectomy was performed, two strands of unidirectional sutures were used. They were preplaced at the mesenteric and antimesenteric borders and anchored by placing the needle through their respective loop. Each strand was used to complete half of the enterectomy. Each half of the enterectomy was completed by overlapping the starting point of the other strand with two extra stitches at 180°. Simple interrupted sutures with 4-0 glycomer 631 (Biosyn) were added in one gastrotomy, three enterectomies, and three enterotomies that were primarily closed with unidirectional barbed sutures to correct any substantial gaps in the simple continuous closure.

Short-term follow-up information was collected on 29 cases, including three cats and 26 dogs. In 12 cases, university medical records were available from our hospital, in 11 cases medical records were received by the primary care veterinarian, and in five cases direct contact with an owner was made. In three cases, patient information was received from multiple sources. None of the cases were diagnosed with leakage or dehiscence at the site of gastrointestinal surgery resulting in septic peritonitis before discharge. One cat became tachycardic and vomited while in the critical care unit for postoperative hospitalization. Six dogs had episodes of vomiting and regurgitation, two had episodes of tachycardia and one required additional opioid pain medications to control postoperative pain. The median postoperative hospitalization time was 1 day (range: 1-3 days). After being discharged from the hospital, one dog developed a subcutaneous seroma at the laparotomy site. Another dog had a surgical site infection in the skin and subcutaneous tissue treated with antibiotics, which ultimately healed after being flushed and reapposed with sutures. One dog died before suture removal from seizure complications associated with an extrahepatic portosystemic shunt attenuation at the time of surgery. There were no reports of septic peritonitis in any of the cases during short-term follow up.

Long-term follow up was collected on one cat and 18 dogs. In five cases the follow-up information was collected from university medical records at our institution, in 10 cases it was collected from medical records received from primary care veterinarians, and in five cases direct contact with the owner was made. In one case information was collected from multiple sources. Median long-term follow up was 1076 days (Range: 20-2179 days) after surgery. Two out of 18 dogs (11.1%) with long-term follow up developed strictures and adhesions requiring a second surgery 20 and 27 days after surgery. The first surgeries for these cases were one enterectomy and one enterotomy. At the time of the first surgery, the enterectomy had ischemia secondary to intestinal mesenteric volvulus isolated to one loop of the jejunum, and the enterotomy was a foreign body removal. Both complications were corrected with an enterectomy with 4-0 glycomer 631 (Biosyn). The histopathological analysis for the enterectomy case reported a chronic-active, diffuse suppurative, lymphoplasmacytic enteritis with hemorrhage and foreign material (specific details not reported) in the submucosa. In the enterotomy case, a multifocal mural abscess with chronic-active dystrophic mineralization and mild suppurative enteritis was reported. There is no reported culture for the multifocal mural abscess. Follow up was available in one case after the second surgery, and no further complications were reported.

4 | DISCUSSION

Utilization of absorbable unidirectional barbed sutures was not associated with leakage or dehiscence after gastrointestinal surgery. In the long term, two dogs developed an intestinal obstruction at the site of previous intestinal surgery, performed with an absorbable unidirectional barbed suture. In both cases, an enterectomy was required to correct the obstruction.

The population of dogs and cats in this study is very similar to populations reported in other studies on gastrointestinal surgery.^{3,6,10,32,33} Age and sex distributions in the population of this study are similar to other populations of retrospective studies involving dogs.^{3,6,10,32,33} Our cat population is younger than the population described by Hiebert et al.³⁴ In our study all cats had obstruction related to a foreign body. In contrast, Hiebert et al.³⁴ had a population with a wider range of indications for gastrointestinal surgery. In similarity to other retrospective studies on gastrointestinal surgery in dogs, the most common indication for gastrointestinal surgery in our population was an obstruction due to a foreign body.^{7,11,12,33,35}

None of the dogs in this study developed septic peritonitis within the short-term follow up after surgery indicating that leakage and dehiscence did not happen. Leakage and dehiscence are the two most common causes of septic peritonitis after gastrointestinal surgery, which will most often occur within the first 5 days after surgery. The rate of septic peritonitis after gastrointestinal surgery has been reported between 2.0% and 16%.^{3,5-7,10-12,32,33,35,36} The risk of dehiscence after intestinal surgery is greatest at 3 days postoperatively.³⁷ Jonsson et al.³⁷ further concluded there to be 3 days of weakening followed by a fast rise in strength that terminates with complete intestinal strength after 14 days with minimal mechanical strength being contributed by the suture itself. The unidirectional barbed suture used in this study was made of glycomer 631, which loses 25% of its tensile strength at 14 days, and 60% after 21 days postimplantation.²

Hansen et al.²⁶ showed, in an *ex vivo* study, that enterotomies completed with unidirectional barbed sutures leaked at a higher pressure than enterectomies performed with standard sutures. They hypothesized that unidirectional sutures were able to maintain a better apposition of tissue, which would explain the higher leakage pressure. Fealey et al.³⁸ did not show an increased leakage pressure with unidirectional barbed sutures when resection and anastomoses were performed in the canine cadaveric intestine. Fealey et al.³⁸ and Hansen et al.²⁶ utilized different suture manufacturers which may have contributed to the difference in the results. Barbed sutures are built from regular monofilament sutures in which barbs are cut. Depending on the

technique used to create the barbs, the barbs might be of different sizes and shapes resulting in larger suture holes that could leak at lower pressure. Ehrhart et al.²⁷ evaluated the bursting strength of enterotomies and gastronomies performed with unidirectional barbed sutures at 3, 7, and 14 days after surgery in dogs. This study concluded that unidirectional barbed sutures were not associated with a reduction of bursting strength in comparison with standard sutures. There is therefore no evidence to suggest unidirectional barbed sutures negatively impacted healing potential during gastrointestinal surgery in dogs.²⁷ The surgical site should heal beyond the debridement phase, in a similar way to the healing that occurs when standard sutures are used.^{27,31}

Unidirectional barbed sutures are not associated with an increased risk of fibrosis, adhesions, abscessation, or stenosis when used in gastrointestinal surgery.^{27,31} However, two of 18 dogs (11.1%) with long-term follow up presented for return of clinical signs consistent with obstruction at days 20 and 27 postoperatively. One complication occurred at an enterotomy site, and the other at an enterectomy site. Both dogs required an enterectomy of the affected site. The histology of both sites was consistent with an inflammatory reaction, including leukocyte infiltration into tissue and abscessation leading to luminal narrowing. DePompeo et al.¹¹ reported the impaction of four of 87 (4.5%) surgical sites after using stapling equipment to perform an enterectomy months to years after surgery. Intestinal-wall abscesses have been reported at a rate of 5% and 3.3% in dogs and after using stapling equipment, with abscessation developing within the first 5 days after surgery.^{14,39} Ehrhart et al.²⁷ did not report any signs of impaction or stenosis in their study in dogs; however, only enterotomies were performed. Bautista et al.²⁵ did not report any stricture formation or impaction in a series of gastrointestinal surgeries performed on 50 human patients with laparoscopic Roux-Y gastric bypass procedures. Unidirectional barbed sutures have the potential to affect the healing process by decreasing blood supply to the edge of the tissue.^{18,19} Vesicourethral anastomoses completed with unidirectional barbed sutures have been associated with an increased amount of fibrosis and an increased risk of urine leakage during the healing process, likely because the sutures were applied with too much tension, affecting blood flow.^{18,19} It is therefore possible that the use of too much tension in those two dogs resulted in more inflammation at the surgical site and fibrosis. The barbs may also create some trauma to the wall of the intestine, inducing inflammation and fibrosis. However, one would expect complications with leakage in the postoperative period rather than fibrosis and stenosis 3 weeks after surgery. In the case of the enterectomy, the unidirectional

barbed suture may have a purse-string effect, even when two strands are used, as the unidirectional barbed sutures do not release tension after it advances and engages the tissue. Clapp et al.⁴⁰ reported 14 cases of small bowel obstruction after using unidirectional barbed sutures in human patients. The most common finding in these cases was the loose tails of unidirectional barbed sutures causing adhesions to other bowel serosa and mesentery, with secondary volvulus in five cases. In this study, the loose tails of the suture were not a source of stricture at the surgical site.

This study has several limitations related to its retrospective nature. As this is a descriptive study, no control group was treated with standard monofilament sutures, and there is less control of confounding variables between cases. A randomized clinical trial to compare unidirectional barbed sutures and standard monofilament sutures is now appropriate. The same board-certified surgeon performed the surgeries. This could create selection bias as it is not a randomized selection process. The surgeon performing gastrointestinal surgery in these cases is very experienced with the use of barbed sutures. There were no dogs or cats with severe peritonitis at the time of surgery in this study, which is probably biased in the case selection by the surgeon. Two cases had mild septic peritonitis in this study. A prospective study would better evaluate the impact of peritonitis on the healing of gastrointestinal surgery performed with unidirectional barbed sutures. It was not possible to evaluate risk factors for failure of the unidirectional barbed suture as leakage and dehiscence did not occur in this study. This would be better addressed in a randomized clinical trial.

Absorbable unidirectional barbed sutures can be used to perform gastrointestinal surgery in dogs and cats. It was not associated with a risk of leakage or dehiscence in this study. The development of obstruction at the previous surgical site in 11.1% of dogs needs further investigation to evaluate the role of the unidirectional barbed suture in the development of impaction, stricture, or fibrosis.

AUTHOR CONTRIBUTIONS

Williams EA, DVM: Author; primary study investigator responsible for acquisition, analysis, and interpretation of data. Monnet E, DVM, Ph.D., DACVS, DECVS: Author, primary surgeon in all cases, primary editor, mentor of professional scientific writing.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest related to this report. Sutures were used with no financial support from, or association with, the manufacturing company.

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