Outcome of Electrosurgery Versus Scalpel Blade for Intestinal Incisions in Dogs

A Knowledge Summary by

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ISSN: **2396-9776**
Published: **14 Aug 2019**
in: **Vol 4, Issue 3**
DOI: http://dx.doi.org/10.18849/ve.v4i3.243
Reviewed by: **Nausikaa Devriendt (DVM, ECVS) and Hilde de Rooster (PhD, EBVS)**
Next Review Date: **23 Aug 2020**

KNOWLEDGE SUMMARY

PICO question

In dogs that undergo intestinal surgery, does the use of monopolar electrosurgery for intestinal incisions increase the risk of dehiscence when compared to a scalpel blade?

Clinical bottom line

Currently there are two experimental in vivo studies comparing electrosurgery with scalpel blade intestinal incisions in dogs, one in cats and one in pigs. In dogs and cats, there is data regarding incisions on the large intestine but not the small intestine.

Colotomy and colectomy performed with monopolar electrosurgery has resulted in significant mortality (up to 60%) during the short-term postoperative period in dogs. Although the studies reviewed have several limitations, the outcome using scalpel blades was significantly better, therefore colonic surgery using electrosurgery is contraindicated. It is likely that small intestinal surgery has the same contraindication but more definite conclusions cannot be made until higher quality evidence is available.

The evidence

All of the studies reviewed here are randomised controlled trials, therefore they provide strong evidence regarding the use of electrosurgery in intestinal surgery in dogs. Two studies in dogs, one study in cats and one study in pigs are available. The canine trials were precisely designed but there were several limitations arising from the fact that these studies were conducted by human surgeons as experimental models. The studies in cats and pigs were included because they address the clinical question fulfilling most of the criteria of an accurate design, despite the different animal species.

Summary of the evidence

Hottenrott et al. (1983)	
Population:	Cross-breed dogs
Sample size:	12 dogs
Intervention details:	• Group 1 (six dogs): Left partial colectomy (2 cm length from descending colon) with a scalpel blade and scissors under local relative ischaemia conditions (ligation of the caudal mesenteric artery and maintenance of mean arterial blood pressure of 40 mmHg for 15 min). Functional end-to-end single-layer anastomosis with polyglactin 910. Two 0.5 × 2 cm sized colonic biopsies collected proximally to the anastomotic site with scalpel blade – scissors and defect closed with single-layer polyglactin 910 sutures. • Group 2 (six dogs): Same procedure as above but the colectomy and colonic biopsies were performed with monopolar electrosurgery.

	• Hospitalisation and monitoring for 4 days. The descending colon was harvested after euthanasia on day 4 postoperative.
Study design:	Randomised, controlled in vivo experimental trial
Outcome studied:	• Postoperative assessment of clinical abnormalities during 4 days • Necropsy assessment of colonic wounds healing • Histopathology of colonic wounds healing • Postoperative measurement of hydroxyproline concentration in colonic wounds
Main findings: **(relevant to PICO question):**	• Group 1: 1/6 dogs died before day 4 postoperative because of anastomotic failure and septic peritonitis. The rest of the animals showed sufficient healing on necropsy. • Group 2: 3/6 dogs died before day 4 postoperative because of anastomotic failure and septic peritonitis. The rest of the animals showed small areas of insufficient healing covered with omentum and major adhesions on necropsy. • Evidence of enhanced colonic wound healing in Group 1 compared to Group 2 (production of granulation tissue, epithelialisation, numbers of fibroblasts, degree of collagen deposition and width of wound) • Significant ($P<0.05$) decrease in concentration of hydroxyproline in colonic wounds of the Group 2 compared to Group 1.
Limitations:	• A partial colectomy was performed in dogs, as a human model, in this study, which is not a commonly performed procedure in dogs in clinical practice. • Small study population • The authors have deliberately simulated conditions of relative ischaemia at the anastomotic site which is a major risk factor for colonic wound healing. • No electrosurgery settings (generator brand, cutting/coagulation, voltage, time) are reported. • The histopathological assessment of the wounds healing is subjective. • Animals were euthanised in 4 days, therefore the longer-term complications and outcome is unknown.

Regadas et al. (2005)	
Population:	Cross-breed dogs
Sample size:	40 dogs
Intervention details:	• Mechanical preparation of the large intestine with an enema of 120 ml 10% glycerine solution 12 h and 2 h pre-operative. • Group IA (10 dogs): Midline laparotomy and transverse colotomy with electrosurgery. • Group IB (10 dogs): Four-port laparoscopy and transverse colotomy with electrosurgery. • Group IIA (10 dogs): Midline laparotomy and transverse colotomy

	with scissors. • Group IIB (10 dogs): Four-port laparoscopy and transverse colotomy with scissors. • Closure of the colotomy with single-layer, interrupted, polydioxanone 0 sutures, not incorporating the mucosa. • Hospitalisation and monitoring for 7 days. Laparotomy and euthanasia at day 7.
Study design:	Randomised, controlled in vivo experimental trial
Outcome studied:	• Postoperative assessment of clinical abnormalities during 7 days • Necropsy assessment of colonic wounds healing • Postoperative measurement of colonic wounds resistance to increased intraluminal pressure with a sphygmomanometer • Histopathology of colonic wounds healing
Main findings: **(relevant to PICO question):**	• Groups IIA and IIB: All animals (20/20) had good postoperative clinical outcome and survived to day 7. • Groups IIA and IIB: All animals (20/20) showed uneventful macroscopic colonic wound healing. • Groups IA and IB: Anorexia, vomiting, diarrhoea and death on day 4–7 postoperative in 5/10 and 6/10 animals respectively. • Group IA: 3/10 animals showed normal healing, 2/10 had omental adhesions to colonic wounds and 5/10 had dehiscence and peritonitis. • Group IB: 2/10 animals showed normal healing, 2/10 had omental adhesions to colonic wounds and 6/10 had dehiscence and peritonitis. • Statistically significant ($P<0.005$) difference between groups I and II but not between groups IA and IB with regards to clinical outcome. • Statistically significant ($P<0.005$) difference between groups I and II with regards to macroscopic wound healing. • Groups IIA and IIB: None of the animals had colonic wound dehiscence after application of a mean intraluminal pressure of 222.1 mmHg. • Groups IA and IB: 3/10 and 2/10 colonic wounds resisted a mean 222.1 mmHg of pressure respectively. 2/10 colonic wounds from each groups failed under mean pressure of 94 mmHg. • Histopathology of colonic wounds at day 7 postoperative revealed an inflammatory process in all groups.
Limitations:	• A human model colotomy was performed in dogs in this study, which is not a commonly performed procedure in dogs in clinical practice. • Mechanical preparation of the large intestine was performed which is largely controversial in colonic surgery, both in humans and small animals due to increased risk of intraoperative contamination with liquid feces. • No electrosurgery settings (generator brand, cutting/coagulation, voltage, time) are reported. • A polydioxanone 0 suture material was used for colotomy

	closure which is significantly over-sized. Generally polydioxanone 3-0 or 4-0 is recommended. • No detailed and/or quantified histopathology results are provided. • Animals were euthanised in 7 days, therefore the long-term complications and outcome is unknown.

Kott & Lurie (1973)	
Population:	Cross-breed cats
Sample size:	40 cats
Intervention details:	• Preparation of the large intestine with only water per os for 48 h pre-operatively. • Group I (20 cats): Partial colectomy of a 2 cm segment from the descending colon with a stainless steel scalpel blade. • Group II (20 cats): Partial colectomy of a 2 cm segment from the descending colon but using electrosurgery. • End-to-end anastomosis in two layers: appositional pattern in the mucosa and inverting pattern in the seromuscular layer using 5-0 silk interrupted sutures. • Hospitalisation and monitoring for 1 day (8 cats), 2 days (8 cats), 4 days (8 cats), 6 days (8 cats) and 11 days (8 cats). • Specimens with the colectomy wounds were randomly harvested on necropsy after euthanasia on postoperative days 1 (8 cats), 2 (8 cats), 4 (8 cats), 6 (8 cats) and 11 (8 cats).
Study design:	Randomised, controlled, in vivo experimental trial
Outcome studied:	• Intraoperative findings were recorded. • Necropsy assessment of colonic wounds healing • Histopathology of colonic wounds healing (40 specimens, 8 specimens for each of the days 1, 2, 4, 6 and 11 [20 specimens from Group I and 20 from Group II])
Main findings: **(relevant to PICO question):**	• Haemostasis during colectomy with electrosurgery was superior to stainless steel scalpel blade. No macroscopic compromise of the vascular supply or the viability of the colonic wall was observed in any of the animals. • No dehiscence was found on necropsy assessment in any of the animals. • Group II anastomotic sites were oedematous and friable. There were adhesions and local peritonitis. • The overall wound healing process was delayed by 48 h in Group II compared to Group I, mostly evident in day 4 and 6 postoperative (necrotic tissue, exudates of fibrin and leucocytes, incomplete fusion of the muscular layer). No quantitative data are provided.
Limitations:	• No electrosurgery settings (generator brand, cutting/coagulation, voltage, time) are reported.

	• Colectomy closure was performed in a double-layer pattern, no submucosal apposition is mentioned and the superficial layer was closed in an inverting pattern. This technique is generally regarded as inappropriate for colonic closure in companion animals (Williams 2017). • A 5-0 silk suture material was used for colectomy closure which is generally considered an inappropriate material (increased capillarity, tissue drag, predisposing to infection, non-absorbable) [Williams 2017]. • Animals were euthanised on days 1, 2, 4, 6 and 11, therefore the longer-term complications and outcome is unknown. • The findings from the histopathology of the colonic wounds' healing were presented and compared in detail but no quantitative data are provided.

Pollinger et al. (2003)	
Population:	Pigs, Domestic-cross, female
Sample size:	18 pigs
Intervention details:	• Full thickness transverse enterotomies using two different feedback circuit electrosurgical generators at 20 W cutting mode and No. 10 scalpel blade. Two enterotomies with each modality. A total of 108 enterotomies. • All enterotomies closed on a single-layer, interrupted pattern with 3-0 braided polyglactin 910. • Specimens with the enterotomy wounds were randomly harvested on necropsy after euthanasia on postoperative days 3, 7 and 14.
Study design:	Randomised, controlled, in vivo experimental trial
Outcome studied:	• Histopathology of intestinal wound healing (54 specimens, 18/modality and 6/each time point/modality): Inflammatory response (cells/high power field [hpf]), Predominant cell species, Thermal injury (mm), Degree of epithelialisation, Density of collagen deposition, Stage of healing • Measurement of wound tensile strength (54 specimens, 18/modality and 6/each time point/modality): Unit-O-Matic FM-20® universal testing machine, within 60 min from necropsy
Main findings: **(relevant to PICO question):**	• Evidence of thermal injury in all specimens incised with electrosurgical devices. Mean width of thermal injury 5.57 mm (range 3–10 mm) with the first generator and 5.28 mm (range 2–9 mm) with the second one. • No significant difference in inflammatory response, predominant cell species, degree of epithelialisation and density of collagen deposition at any time point for the three modalities tested. • Significant difference in the stage of healing between enterotomy sites created via electrosurgery (earlier stage) when

	compared to scalpel blade (later stage) [P<0.0001]. • No significant difference in intestinal wound tensile strength at any time point for the three modalities tested.
Limitations:	• No limitations detected

Appraisal, application and reflection

The use of electrosurgery (diathermy or radiofrequency) to perform intestinal incisions in dogs has never been reported in clinical cases according to the author's research of current veterinary literature. The canine studies reviewed here have investigated the use of monopolar electrosurgery in oncologic colectomy or colotomy as experimental model for humans (Hottenrott et al., 1983 and Regadas et al., 2005). Colectomy and colotomy are not very frequently performed in dogs in clinical practice, particularly in comparison with enterotomy or enterectomy. The anatomy of the intestinal wall is similar in the small and large intestine but the healing process of these two structures differs in a few aspects. Bacterial population is larger in the colon (10^{10}–10^{11} bacteria per gram of faeces) which could be predisposed to infection. Return of wound-bursting strength is slower in the colon than in the small intestine with 75% of the normal strength being reached at 4 months postoperative (Williams, 2017). Collagenolysis 48 h after surgery has been shown to be much more activated in the colon compared to the small intestine (Thornton et al., 1997). The colonic intraluminal pressures may be higher than the small intestinal ones as faecal masses pass through. Also, in one of the studies (Hottenrott at al., 1983) tissue hypoperfusion was evoked. Both infection and hypoperfusion are factors that can negatively affect the colonic wound healing regardless of the modality used for the incision. However, the same factors were present in the control groups in both studies. There was a significant difference in complications rate, mortality rate, macroscopic and microscopic healing progress (Hottenrott et al., 1983 and Regadas et al., 2005) and colonic wounds bursting strength (Regadas et al., 2005). It can be concluded that the use of electrosurgery in colonic surgery in dogs is contraindicated.

In a feline study (Kott and Lurie, 1973) a fair number of colectomies (40 colectomies) was performed using electrosurgery. Subtotal/total colectomy (but not partial colectomy as in this study) is more frequently performed in cats than in dogs, to treat idiopathic megacolon. Although there were no reported postoperative complications and mortality, these clinical aspects were not the main objective of the study and they were briefly mentioned in the Materials and Methods section. In addition, most of the animals were euthanised by day 4 postoperative (24/40) which can obscure the true complications and mortality rate. Histopathology of the wound healing revealed an overall delayed healing when the wounds were created via electrosurgery. In those wounds, there was necrosis at the wound edges up to 4 days postoperative, the fibroblastic proliferation was delayed at all time points, maturation of the granulation tissue had not occurred at day 11 postoperative and fusion of the individual layers was not observed up to day 11 postoperative. Although these results are not quantified, they can be considered strong evidence against the use of diathermy in colonic surgery in cats.

Contrarily to the previous data, a large number of enterotomies (72 enterotomies) using electrosurgery was performed in pigs with no complications or mortality reported until the day 14 postoperative (Pollinger et al., 2003). Histopathology of the wound healing revealed an overall delayed healing when the wounds were created via electrosurgery but no significant differences in specific histologic parameters or tensile wound strength were found. Pigs have an unusual distribution of mesenteric arterial blood supply with approximately 500 bundles of arteries consisting of up to 30 anastomosing arteries each (Spalding, 1987). Although these results do not show a clear clinical disadvantage of feedback circuit electrosurgery in comparison to "cold instrument" intestinal surgery, an experimental or clinical study in dogs would be necessary for safe conclusions to be drawn.

Methodology Section

Search Strategy	
Databases searched and dates covered:	CAB Abstracts on OVID Platform covering from 1973 to 2018 Week 32. PubMed via the NCBI website covering from 1910 to August 2018. Google Scholar covering from 1982 to 2016.
Search terms:	CAB Abstracts 1. (dog or dogs or canine or canines or canis or bitch or bitches or puppy or puppies or pup or pups).mp. or exp dogs/ or exp bitches/ or exp puppies/ or exp canidae/ or exp canis/ (222717) 2. (enterotomy or enterectomy or intestinal or intestines or intestine or bowel or bowels).mp. or exp intestines/ (189759) 3. (diathermy or diathermic or electrosurgery or electro-surgery or electrosurgical or electro-surgical).mp. (247) 4. (scalpel or blade or bladed or "conventional surgery" or "cold instruments" or "cold instrument").mp. (11131) 5. 1 and 2 and (3 or 4) (20) PubMed 1. (dog OR dogs OR canine OR canines OR canis OR bitch OR bitches OR puppy OR puppies OR pup OR pups) 2. (enterotomy OR enterectomy OR intestinal OR intestines OR intestine OR bowel OR bowels) 3. (diathermy OR diathermic OR electrosurgery OR electro-surgery OR electrosurgical OR electro-surgical) 4. (scalpel OR blade OR bladed OR "conventional surgery" OR "cold instruments" OR "cold instrument") 5. 1 AND 2 AND (3 or 4) (20) Google Scholar 1. (intestine OR intestinal OR enterotomy) 2. (electrosurgery OR electrosurgical OR diathermy) 3. (scalpel AND blade) 4. (wound healing OR dehiscence) 5. 1 AND 2 AND 3 AND 4 (4,020) The reference list for the studies that were identified has also been searched.
Dates searches performed:	23/08/2018

Exclusion / Inclusion Criteria	
Exclusion:	Opinion pieces, articles on intestinal surgery and diathermy but not for creation of incisions, articles on intestinal surgery and different cutting modalities (laser, harmonic scalpel) and articles that were not relevant to the PICO question.
Inclusion:	Articles that were relevant to the PICO question. The articles did not have to be from the veterinary literature. Case reports were considered but none was retrieved. The reference list for the studies that were identified has also been searched.

Search Outcome							
Database	**Number of results**	**Excluded – Opinion pieces**	**Excluded – Diathermy not used for incisions**	**Excluded – Different cutting modalities (laser, harmonic scalpel)**	**Excluded – Not relevant to PICO question**	**Excluded – Not accessible**	**Total relevant papers**
CAB Abstracts	20	0	1	5	14	0	0
PubMed	20	0	3	4	9	2	2
Google Scholar	4,020	0	0	0	4,019	0	1
Reference list checking	4	0	0	0	3	0	1
Total relevant papers when duplicates removed							**4**

CONFLICT OF INTEREST

The author declares no conflicts of interest.

The author would like to thank Ana Ferreira and Lukas Huber from the University of Glasgow Small Animal Hospital for their valuable help in translation of two articles that were not in English.

REFERENCES

1. Hottenrott, V.C., et al. (1983) Anastomotic problems in colonic surgery. *Zentralblatt fur Chirurgie*. 108: 1263–1271.
2. Kott, I., and Lurie, M. (1973) The effects of electrosurgery and the surgical knife on the healing of intestinal anastomoses. *Diseases of the Colon & Rectum*. 16: 33–38. DOI: http://dx.doi.org/10.1007/BF02589907
3. Pollinger, H.S., et al. (2003) Comparison of wound-healing characteristics with feedback circuit electrosurgical generators in a porcine model. *The American Surgeon.* 69: 1054–1060.
4. Regadas, S.M.M., et al. (2005) Experimental model of laparoscopic handsewn suture in colon of dogs. Acta Cirúrgica Brasileira 20: 323–328. http://dx.doi.org/10.1590/S0102-86502005000400011
5. Spalding, H., and Heath, T. (1987) Arterial supply to the pig intestine: an unusual pattern in the mesentery. *Anatomical Record*. 218: 27–29. DOI: http://dx.doi.org/10.1002/ar.1092180106
6. Thornton, F.J., and Barbul, A. (1997) Healing in the gastrointestinal tract. *Surgical Clinics of North America*. 77: 549–573. DOI: https://doi.org/10.1016/S0039-6109(05)70568-5
7. Williams, J.M. (2017) Colon. In: Veterinary Surgery: Small Animal, 2nd ed., eds K.M. Tobias, S.A. Johnston, Elsevier, St. Louis, MO, USA, pp. 1767–1771.

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