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ORIGINAL ARTICLE

Comparison of Polyethylene Glycol and Senna Solutions in Colon Preparation before Radiography and Colonoscopy in Dogs

Majid Zakerian¹, Reza Avizeh^{2*}, Alireza Ghadiri², Mohammad Razi Jalali², Mahdi Pourmahdi³, Hossein Najafzadeh Varzi⁴

¹ MVSc Graduated of Small Animal Internal Medicine, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

² Department of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

³ Department of Food Hygiene, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

⁴ Department of Basic Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

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Abstract

Objective- The aim of this study was to evaluate the efficacy and safety of senna as an alternative or adjunct to polyethylene glycol (PEG) solution in dogs using radiography and colonoscopy.

Design - Experimental study.

Animals - 20 adult mongrel healthy dogs.

Procedures- Dogs were randomly allocated to receive 1 of 4 different bowel preparation regimens including PEG, senna or their combinations in addition with enema before colonoscopy. Radiologist unaware of the method of bowel preparation, reviewed the standard radiographs and graded the feces and gas in the colon and rectum, fecal radio-opacity and quality of radiographs on a scale of 0 to 3 (0=inadequate to 3=excellent). The degree of colonic cleansing was assigned a score of 1-4 (1= clean colon to 4= excessive fecal material) to each of five regions of the colon. Dogs were examined for any drugs side effects up to two weeks after administration of the laxatives.

* Correspondence to: Reza Avizeh, Department of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Chamran University of Ahvaz, Ahvaz, Iran.

E-mail: avizeh@scu.ac.ir

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Results- Anesthesia and colonoscopy were performed without complication in all dogs. PEG was demonstrated to be equal or slightly more effective than senna using radiography and colonoscopy ($p < 0.05$). There were no side effects or complications attributable to each laxative agent.

Conclusion and Clinical Relevance- Polyethylene glycol lavage solution has been proved to be similarly safe and effective as senna for bowel preparation in dogs. Senna can be used as an alternative or adjunctive medication to potentiate the cathartic action of PEG in dogs.

1. Introduction

Diseases of the colon are relatively common in small animal medicine. The most of colonic diseases have mucosal involvement, and therefore, a proper diagnostic evaluation often includes direct visual inspection of the colon.¹⁻³ Thus, colonoscopy has become the method of choice for investigating clinical signs of colonic disease in dogs and cats. Furthermore, this technique will usually provide a definitive diagnosis of common colonic conditions, especially in the dog. The aim of patient preparation before colonoscopy as well as radiography is to completely evacuate feces from the colon (cecum to the rectum), for adequate visualization of the mucosa and enhanced biopsy quality.⁴

The current bowel-cleansing protocols used in dogs were initially extrapolated from protocols used in humans, and are now based on clinical experience and the results of three previous studies in dogs.⁵ Polyethylene glycol is a non-absorbable, non metabolized osmotic agent which despite its incomplete colon cleansing, widely used for bowel preparation before colonoscopy.⁶ On the other, it is associated with several disadvantages.⁷ In a review of dogs undergoing colonoscopy, vomiting occurred in at least 6.5% of dogs receiving this preparation. Also aspiration of PEG during its administration is fatal.⁸

Senna (*Cassia angustifolia*), is an evergreen tree that commonly grows in Africa, India and Iran which widely used in the treatment of constipation. Its leaves and pods contain anthraquinonoid glycosides (sennosides) that exerts its action by increasing bowel motility, and it leads to the accumulation of water and electrolytes within the lumen of the colon.⁹ There is no information about its efficacy and safety in bowel cleansing in dogs. Only one study has been evaluated its effects on colon preparation in dogs based on abdominal radiography, while no research has been performed to evaluate the efficacy of the senna using colonoscopy in dogs.¹⁰ Sena-graph is a 60 ml watery texture syrup that has been formulated by an Iranian pharmaceutical company for being used in bowel evacuation.¹¹ The purpose of this study was to compare the efficacy and safety of senna with PEG as an alternative or adjunct use in dog by colonoscopy and radiography. So in this case, senna solution can be used as a cheap and available drug for bowel preparation.

2. Materials and Methods

Twenty adult (1.5 – 2.5 years old) healthy mongrel dogs of both sexes with an average weight of 22.05 ± 2.23 kg were used in this study. During the two weeks adaptation period, antiparasitic drug (Caniverm, Bioveta, Czech Republic), polyvalent (DHPPiL, Canvac, Czech Republic) and rabies (Canvac, Czech Republic) vaccines were administered. Dogs were fed with the standard dry commercial food with 29% protein and 9-10% fat at 300 to 400 g per day, based on body weight. The dogs were divided randomly into four equal groups. Food intake was withheld 15 hours before the first laxative administration, but dogs were allowed free access to water.

The dogs in the first group received 8 mg/kg of body weight polyethylene glycol (Klean Prep, Helsin- Birex Pharmaceutical Ltd., Dublin, Ireland) dissolved in one liter of water by stomach tube slowly over a 3 minute period. Twenty minutes later a 20 ml/kg warm water enema was administered. PEG and enema administration were repeated 4 hours after the initial dosing. In the next morning, an additional warm water enema was performed prior to radiography and colonoscopy.⁵ It should be noted that before administration of laxative solutions in dogs, tranquilizers (acepromazine maleate plus ketamine hydrochloride) with minimal sedative effect were used.

Every dogs in the second group received 20 mg/kg body weight of senna (Sena-graph, Iran Darouk, Tehran, Iran), instead of polyethylene glycol in group 1, diluted in one liter of water and 20 ml/kg warm water enema in the same manner as in the first group.

Dogs in the third group received combination of PEG and senna with the same doses of the first and second groups in one liter of water plus enema, and the dogs in the fourth group received half the dose of PEG and senna plus enema. Radiography (Mobile Toshiba x-ray machine, Japan) and colonoscopy (VetVu, Swiss) were performed approximately 24 hours after initiation of bowel preparation.

Plain lateral radiographs from the abdominal cavity of dogs were taken (Kvp 70, mAs 40, FFD=90) at three times. The first and second radiographs of each dogs were prepared immediately before and after adaptation period. The third stage radiography was carried out one hour after last enema administration and before colonoscopy. Radiologist

Table 1. Scoring system of abdominal radiographs of dogs receiving polyethylene glycol or senna bowel preparation.

Score	Quality	Definition	Factor
0	Inadequate	Gas in over 12 intestinal loops	Gas presence
		Feces in more than two thirds of colon	Feces in colon
		Feces in more than two thirds of rectum	Feces in rectum
		Feces radiopacity almost equals the ribs	Feces radiopacity
1	Moderate	Gas seen in 6-12 intestinal loops	Gas presence
		Feces in more than one third to two thirds of the colon	Feces in colon
		Feces in more than one third to two thirds of the rectum	Feces in rectum
		Feces radiopacity less than the ribs	Feces radiopacity
2	Good	Gas seen in 3-6 intestinal loops	Gas presence
		Feces in one third of colon	Feces in the colon
		Feces in one third of the rectum	Feces in the rectum
		Feces is hardly seen	Feces radiopacity
3	Excellent	Gas seen in less than three intestinal loops	Gas presence
		No feces in the colon	Feces in the colon
		No feces in the rectum	Feces in the rectum
		No feces	Feces radiopacity

unaware of the method of bowel preparation, reviewed the standard radiographs and graded the feces and gas in the colon and rectum and fecal radio-opacity a scale of 0 to 3 (0 = inadequate, 1 = moderate, 2 = good and 3 = excellent) (Table 1).

Colonoscopy was performed to the level of the cecum in left lateral recumbency as described previously by Daugherty and co-workers. Endoscopy of the colon is performed with the animal placed in left lateral recumbency to avoid the accumulation of fluid in the transverse colon and to facilitate passage of the colonoscope at the splenic flexure. An observer unaware of the bowel preparation method utilized scored the colon preparation according to the following:

1 = Clean Colon: no fecal matter or nearly none, no residual fluid.

2 = Relatively Clean Colon: small amounts of thin, adherent liquid fecal matter, suctioned/flushed easily.

3 = Relatively Unacceptable Preparation: Moderate amounts of liquid to semisolid or adherent fecal matter, difficult to suction/flush from the colon, mucosa still visible.

4 = Unacceptable Preparation: Large amounts of solid or adherent fecal matter precluding adequate examination.

Five regions of the colon were scored including the distal, mid-portion, and oral portion of the descending colon, the transverse colon, and the ascending colon. Finally total colon cleansing score was calculated as the sum of the 5 regional colon scores.

Dogs were observed for any drug side effects up to two weeks after administration of the laxatives.

Statistical evaluation of this study was performed by SPSS software version 16. The data obtained from radiography were analyzed by the Friedman statistical test. Also Wilcoxon test was used to examine the significant differences between each of the three stages of radiography. Kruskal-Wallis statistical test was used to compare the results of colonoscopy. In cases where $p < 0.05$ resulted, a significant relationship was considered.

3. Results

Intubation and intragastric administration of the solutions and colonoscopy were performed without complication in all dogs. Results of physical examination were normal before and up to two weeks after the end of study. None of the dogs showed clinical signs of vomiting, regurgitation, diarrhea, nausea, weight loss and coughing as well as dermatologic symptoms up to two weeks after the end of study. Only one dog vomited immediately after PEG administration which was withdrawn from the study.

Means of regional and total colon scores are presented in Table 2. Based on statistical evaluation, there are significant differences in all regions and total colon scores between groups ($p < 0.05$). Also there are significant differences between group 4 with groups 1 and 3 in all colon regions ($p < 0.05$). Only significant difference between groups 2 and 3 was in ascending colon ($p < 0.05$). Statistical analysis of total colon scores showed significant differences between groups 1 and 4 ($p = 0.006$), groups 1 and 2 ($p = 0.04$), groups 3 and 4 ($p = 0.006$) as well as groups 2 and 3 ($p = 0.02$).

Table 2. Means \pm standard errors of regional and total colon scores after bowel preparation with polyethylene glycol and senna in dogs.

Regions Groups	Ascending Colon	Transvers Colon	Orad Descending Colon	Mid- Descending Colon	Distal Descending Colon	Total Colon Scores
1	2.20 \pm 0.20	2.40 \pm 0.24	1.80 \pm 0.20	1.80 \pm 0.20	1.90 \pm 0.10	10.10 \pm 0.24
2	2.60 \pm 0.24	2.80 \pm 0.20	2.40 \pm 0.24	2.20 \pm 0.20	2.40 \pm 0.24	12.40 \pm 0.92
3	1.80 \pm 0.20	2.20 \pm 0.20	1.60 \pm 0.24	1.80 \pm 0.20	1.80 \pm 0.20	9.20 \pm 0.58
4	2.90 \pm 0.10	3.20 \pm 0.20	2.80 \pm 0.20	2.80 \pm 0.20	2.90 \pm 0.10	14.60 \pm 0.40

Table 3. Means \pm standard errors of radiographic scores after bowel preparation with polyethylene glycol and senna in dogs.

Groups	Time	Fecal Residue in Colon	Fecal Residue in Rectum	Feces Radiopacity	Gas Present in Bowels
1	1	0.60 \pm 0.24	0.40 \pm 0.24	0.40 \pm 0.24	1.40 \pm 0.24
	2	1.40 \pm 0.24	1.40 \pm 0.24	1.40 \pm 0.24	2.20 \pm 0.20
	3	3.00 \pm 0.00	3.00 \pm 0.00	3.00 \pm 0.00	2.40 \pm 0.24
2	1	0.60 \pm 0.24	0.40 \pm 0.24	0.40 \pm 0.24	1.40 \pm 0.24
	2	1.40 \pm 0.24	1.40 \pm 0.24	1.40 \pm 0.24	2.20 \pm 0.20
	3	2.80 \pm 0.20	3.00 \pm 0.00	2.80 \pm 0.20	1.40 \pm 0.24
3	1	0.60 \pm 0.24	0.40 \pm 0.24	0.40 \pm 0.24	1.60 \pm 0.24
	2	1.40 \pm 0.24	1.40 \pm 0.24	1.40 \pm 0.24	2.20 \pm 0.20
	3	3.00 \pm 0.00	3.00 \pm 0.00	3.00 \pm 0.00	1.80 \pm 0.20
4	1	0.60 \pm 0.24	0.40 \pm 0.24	0.40 \pm 0.24	1.40 \pm 0.24
	2	1.40 \pm 0.24	1.40 \pm 0.24	1.40 \pm 0.24	2.20 \pm 0.20
	3	2.80 \pm 0.20	3.00 \pm 0.00	2.80 \pm 0.20	2.20 \pm 0.20

Endoscopic images demonstrating bowel preparation with Polyethylene glycol and senna are shown in Figures 1 and 2.

The results of radiographic evaluation of bowel preparation are summarized in Table 3. The statistical evaluation in this study showed that the changes in all radiographic parameters with except for the presence of gas over time in all groups were significant ($p < 0.01$). There are significant differences in all of the evaluated factors except for the presence of gas in the intestines between the first and second, and first and third stages of radiography in all groups ($p < 0.05$). Also significant differences were observed between the second and third stages of radiography only in groups 1, 3 and 4.

Radiographic images demonstrating bowel preparation with polyethylene glycol and senna are shown in Figures 3 to 5.

4. Discussion

High quality bowel preparation is essential for definitive diagnosis of colon abnormalities during colonoscopy. The purpose of this study was to evaluate the effect of polyethylene glycol and senna on colon preparation, using colonoscopy and radiography and their possible side effects in dogs, so that the senna could be considered as an

alternative to polyethylene glycol if possible. Based on the results of this study, polyethylene glycol significantly cleansed the colon in all regions from the rectum to the cecum. Only three studies have been published describing the effects of various bowel preparation before colonoscopy in dogs. In one of the early studies concluded that the effect of polyethylene glycol is significantly better than warm water enema and lubricating gel.³ Burrows also evaluated three doses of PEG based gastrointestinal lavage solution. The study concluded that the 80ml/kg PEG resulted in significantly better colon cleansing effect.¹ A recent study compared colon preparation with PEG or sodium phosphate in dogs. They did not recommend bowel cleansing preparations with NaP because of the inadequate quality of bowel preparation compared with the protocol using PEG-containing fluids.⁵

In 1980, Davis et al, reported on the development of a polyethylene glycol-electrolyte lavage solution which is non-fermentable and causes minimal water and electrolyte absorption and secretion.¹² Since then, numerous studies have been done in human bowel preparation. So that, in people, PEG has been shown to be effective in colon preparation.¹³⁻¹⁶

Consuming all 4L of PEG on the day before colonoscopy is poorly tolerated as the volume can lead to nausea, cramping, and vomiting. The current practice is to split



Figure 1. Colonoscopy view of distal end of descending colon of a dog after bowel preparation with polyethylene glycol (group1). Small amount of fecal residue, thin and with low adhesion was seen. The colon cleansing score in this image was considered to be 2.



Figure 2. Colonoscopy view of ascending colon of a dog after bowel preparation with half doses of polyethylene glycol and senna (group4). Moderate amounts of liquid to semisolid or adherent fecal matter was seen. The colon cleansing score in this image was considered to be 3.

dose the PEG preparation into 2L doses the evening before and the morning of the exam, usually 5–6 hours before the procedure.¹⁷ Some researchers have tried to introduce a new drug as an alternative to polyethylene glycol. Senna is an anthracene derivative stimulant preparation whose active ingredients, anthraquinones and their glucosides stimulate colonic peristalsis and inhibit water and electrolyte reabsorption.¹⁸ In one study, senna compounds reduced the dose of PEG required for effective colon cleansing, thus increasing tolerability.¹⁹ In another study, 24 tablets of 12mg senna given in divided doses the day before procedure were found to be superior to 4 L of PEG-ELS.²⁰

Also based on the results of this study, there is no significant differences between PEG and senna bowel cleansing effect. Although it should be suggested that the senna increased the cleansing effect of the polyethylene glycol in dogs in this study. Bektas et al, believed that when compared with respect to their efficacies in colon cleansing, safety of application, ease of usage, and side-effects, no significant differences were noted between sodium phosphate, polyethylene glycol and senna solutions.²¹

Administration of dry food for 2 weeks in this study significantly improved radiographic images of the abdominal cavity of dogs. So that the presence of feces in the colon and rectum, the presence of gas in the intestine and the radiopacity of the stool decreased significantly. Also, the results of this study showed that the administration of laxative fluids, especially polyethylene glycol (groups 1, 3 and 4), provided better diagnostic radiographs of the intestines. While in the dogs receiving senna alone (group 2), there was no significant changes in the presence of feces in the colon and total colon preparation score.

Bowel preparation has long been considered necessary to improve the diagnostic quality of subsequent radiologic examination. Gelfand et al, in 1991 believed that the radiologic examination of the colon has been performed for approximately 90 years.²² To the authors' knowledge, there

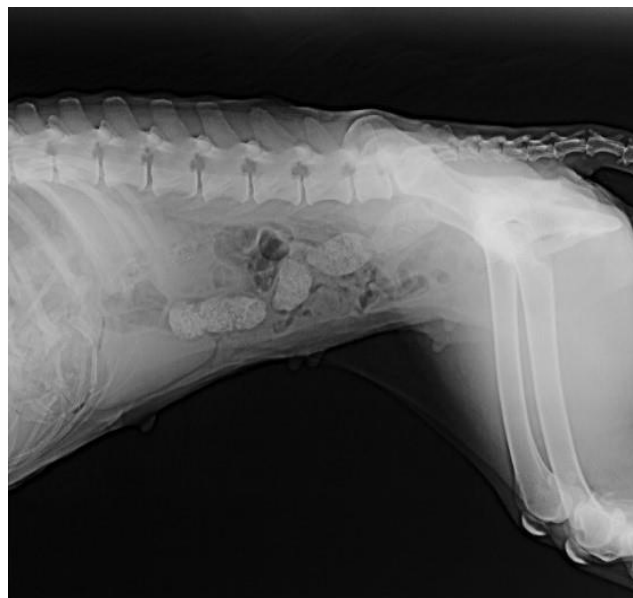


Figure 3. Radiographic view of abdominal cavity of a dog before feeding with commercial dry food. The radiographic scores of fecal amounts in colon and rectum, fecal radiopacity and gas presence in intestine in this image was considered to be 2, 2, 2 and 3 respectively.

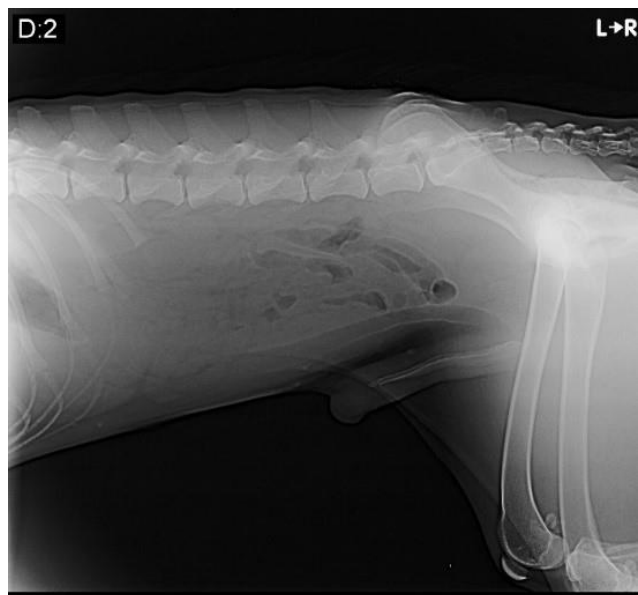


Figure 4. Radiographic view of abdominal cavity of a dog after two weeks feeding with commercial dry food. The radiographic scores of fecal amounts in colon and rectum, fecal radiopacity and gas presence in intestine in this image was considered to be 2, 2, 1 and 3 respectively.



Figure 5. Radiographic view of abdominal cavity of a dog after bowel preparation with polyethylene glycol (group 1). The radiographic scores of fecal amounts in colon and rectum, fecal radiopacity and gas presence in intestine in this image was considered to be 3, 3, 3 and 2 respectively.

is few studies on the use of polyethylene glycol to improve radiographic images of the digestive tract. For example Slanger in 1979 used senna as a radiologic bowel evacuant, which was found to be more effective, better tolerated, and more readily accepted than castor oil.²³ In one study in Iran, senna administration in dogs was superior to castor oil in respect to the presence of stool in colon and the overall quality of the abdominal radiographs, while there was no significant difference between them in relation to

the residual feces in rectum and the accumulation of gas in the intestine.¹⁰ Ghazikhanlou Sani and colleagues, in a similar survey reported that senna regimen is significantly effective and better tolerated than of castor oil regimen in bowel cleansing in human being.¹¹ The majority of researches on laxatives effects has been done in humans in order to improve the radiographic images before excretory urography.²⁴⁻²⁵ Using European Commission Guidelines, Janson and co-workers showed that fulfillment of the image quality criteria was equivalent in the three different preparation groups, including polyethylene glycol, dietary restriction, and no preparation at all.²⁶ On the other hand, they suggest that routine bowel preparation prior to IVP does not improve the visibility or overall quality of control or contrast images.

Based on the results of this study, administration of PEG and senna for bowel preparation in dogs was safe and without any complication or side effects. In all three studies regarding the bowel preparation in dogs, PEG have been reported to be safe. The only clinical signs that they observed included vomiting and regurgitation which was attributed to the rapid orogastric administration of a large fluid volume which resulted in gastric distention. It is possible the combination of rapid gastric distention and stimulation of the gag reflex by the presence of the orogastric tube may have caused the regurgitation in these dogs.^{1,3} Recently, Leib et al, described complications associated with 355 flexible colonoscopic procedures in dogs.⁸ A PEG solution was used in 294 procedures. Major complications occurred during 0.85% of procedures and included fatal aspiration pneumonia after PEG administration, colonic perforation, and excessive bleeding after biopsy. Minor complications associated with anesthesia or colonoscopy occurred in 3.4% of procedures. Vomiting occurred in 6.5% of dogs that received PEG and after 4.6% of the total number of PEG dose administrations. Overall, major and minor complications, including vomiting occurred in 8.5% of colonoscopy procedures and mortality occurred during 0.28% of procedures.

In conclusion, nevertheless, due to its lower cost, lack of dependency, and lack of side effects, we recommend the use of senna in bowel preparation prior to colonoscopy in dogs.

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Conflicts of interest

None.

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نشریه جراحی دامپزشکی ایران

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چکیده

مقایسه پلی اتیلن گلیکول و سنا در آماده سازی کولون پیش از رادیوگرافی و کولونوسکوپی در سگ

مجید ذاکریان^۱، رضا آویزه^۲، علیرضا غدیری^۲، محمد راضی جلالی^۲، مهدیپورمهدی^۳، حسین نجف زاده ورزی^۴^۱ دانش آموخته دکتری عمومی دامپزشکی، دانشکده دامپزشکی، دانشگاه شهید چمران اهواز، اهواز، ایران^۲ گروه علوم درمانگاهی، دانشکده دامپزشکی، دانشگاه شهید چمران اهواز، اهواز، ایران^۳ گروه بهداشت مواد غذایی، دانشکده دامپزشکی، دانشگاه شهید چمران اهواز، اهواز، ایران^۴ گروه علوم پایه، دانشکده دامپزشکی، دانشگاه شهید چمران اهواز، اهواز، ایران

هدف- هدف از این مطالعه ارزیابی اثربخشی و سلامت سنا به عنوان جایگزین یا مکمل محلول پلی اتیلن گلیکول در سگ با استفاده از کولونوسکوپی و رادیوگرافی بود.

طرح مطالعه- مطالعه تجربی.

حیوانات- بیست قلاده سگ بالغ سالم از نژاد مخلوط.

روش کار- سگها به طور تصادفی برای دریافت یکی از چهار رژیم مختلف آماده سازی کولون شامل پلی اتیلن گلیکول، سنا و یا ترکیب آنها به همراه تنقیه پیش از کولونوسکوپی گروه بندی شدند. رادیولوژیست غیر مطلع از روش آماده سازی روده، رادیوگرافهای استاندارد را مورد بررسی قرار داده و میزان حضور مدفوع و گاز را در کولون و رکتوم، رادیوپاسیته مدفوع و کیفیت کلی رادیوگراف را در مقیاس ۰ تا ۳ (۰ = ناکافی تا ۳ = عالی) درجه بندی کرد. برای میزان پاک سازی کولون نیز یک امتیاز ۴-۱ (= کولون تمیز تا ۴ = مواد مدفوع بیش از حد) به هر یک از پنج قسمت کولون اختصاص داده شد. سگها برای هر گونه عوارض جانبی دارو تا دو هفته پس از تجویز ملینها معاینه شدند.

نتایج- بیهوشی و کولونوسکوپی در تمام سگها بدون ایجاد عارضه انجام شد. با استفاده از کولونوسکوپی و رادیوگرافی کارایی پلی اتیلن گلیکول برابر یا کمی مؤثرتر از سنا ارزیابی شد ($P < 0/05$). هیچ یک مواد ملین عوارض جانبی یا سوئی را در پی نداشت.

نتیجه گیری و کاربرد بالینی- کارایی و سلامت محلول لاواژ پلی اتیلن گلیکول برای آماده سازی روده در سگها مشابه سنا اثبات شد.

سنا می تواند به عنوان یک داروی جایگزین یا کمکی برای تقویت فعالیت مسهلی پلی اتیلن گلیکول در سگ استفاده شود.

کلمات کلیدی- پلی اتیلن گلیکول، سنا، آماده سازی روده، کولونوسکوپی، سگ.