Original Article. DOI: 10.22059/ijvm.2019.259726.1004901 *Iranian Journal of Veterinary Medicine*

Effect of Polyethylene Glycol and Senna Bowel Preparation in Dogs on Some Hematological and Serum Biochemical Parameters

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Abstract:

BACKGROUND: Colonoscopy is the preferred procedure for diagnosis of large-bowel diseases in dogs. Polyethylene glycol (PEG) is the most commonly used laxative for colonic cleansing. Senna has been used in traditional medicine as a laxative and an aid to treat constipation.

OBJECTIVES: The aim of this study was to evaluate the safety of senna as an alternative or adjunct to polyethylene glycol solution in dogs using hematology and biochemistry.

METHODS: For this purpose, 20 mongrel dogs were randomly allocated to receive 1 of 4 different bowel preparation regimens including PEG, senna or their combinations plus enema. Serum concentrations of sodium, potassium, total calcium, phosphorus, chloride, magnesium, PCV, total protein, ALT, AST, BUN and creatinine were measured at 0, 1, 2, 5, 6 and 24 hours after the first ingestion of laxative solutions.

RESULTS: Statistical analysis showed that PEG or senna solutions had no significant effect on serum concentration of the evaluated parameters (P>0.05). Despite the significant changes in serum concentration of all measured parameters based on time of sampling in all groups, they were in their normal ranges (P>0.05).

CONCLUSIONS: This is the first evaluation of the safety of bowel preparation with senna in dogs. This study showed that the use of PEG and senna for colon cleansing in dogs did not have any deleterious effects on their serum biochemical and electrolytes concentration.

Keywords:

Colonoscopy, Dog, Laxative, Polyethylene glycol, Senna

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Received: 9 January 2019

Accepted: 17 March 2019

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How to Cite This Article

Zakerian, M., Avizeh, R., Ghadiri, A., Razi Jalali, M., Pourmahdi, M., Najafzadeh, H. (2019). Effect of Polyethylene Glycol and Senna Bowel Preparation in Dogs on Some Hematological and Serum Biochemical Parameters. Iran J Vet Med, 13(2), 175-185. doi: 10.22059/ijvm.2019.259726.1004901

Introduction

Colonoscopy and radiography are the preferred diagnostic methods for colon diseases in dogs and cats. The presence of stool in the colons, on the one hand, makes it impossible to perform colonoscopy, and on the other hand, it prevents the observation of the lesions on the colon mucosa and, therefore, disturbs the diagnosis of colon diseases (Tajika et al. 2017). However, before colonoscopy, imaging or ultrasonography from abdominal cavity food intake should be prohibited for 24 h, prescribing laxative agents and, if necessary, taking an enema is implemented (Rivas et al. 2014).

Polyethylene glycol (PEG) has been widely used as colonic cleansing solution for radiological and colonoscopy procedures for many years, as well as for the treatment of constipation in humans and dogs (Belsey et al. 2012). The high volume of PEG solution and the patient's intolerance have led to recent studies focusing on the effects of alternative or adjunctive drugs (such as senna), along with reduced volume of fluids (Kelly et al. 2012; Santos-Jasso et al. 2017). Until today, in contrast to human medicine, few researches have been conducted to evaluate the safety and efficacy of bowel preparation for colonoscopy in dogs. Veterinary bowel cleansing protocols are also based on clinical experience and the results of three published studies in dogs. So that, in one study complications associated with 355 flexible colonoscopic procedures were described in dogs (Leib et al. 2004). In other study the effect of three different doses of an orally administered PEG based lavage solution was evaluated and it was determined that an 80 ml/kg dose of PEG resulted in better colon cleansing than either 60 or 100 ml/kg dose in dogs (Burrows et al. 1989). Also, other researchers demonstrated that colon preparation with a PEG based solution was superior to enema administration in dogs (Richter & Cleveland 1989). The recent study evaluated the safety and efficacy of oral low-volume sodium phosphate and PEG in dogs (Daugherty et al. 2008).

Senna (*Cassia angustifolia*), is an evergreen tree that commonly grows in Iran and is widely used in the treatment of constipation. Its leaves and pods contain anthraquinone glycosides (sennosides) that exert its action by increasing bowel motility, and it leads to the accumulation of water and electrolytes within the lumen of the colon. Its safety and ease of application are further advantages (Hwang & Jeong 2015). There is no information about its safety and efficacy in bowel cleansing in dogs. In relation the senna, only two studies have evaluated its effects on colon preparation in dogs based on radiographic criteria from the abdominal cavity, while no research has been performed to evaluate the effects of the senna on the laboratory findings (Avizeh et al. 2016; Avizeh et al. 2018).

Laxatives promote evacuation of the bowel through stimulation of fluid and electrolyte transport and increases in propulsive motility. The ideal colon cleansing preparation for diagnostic and surgical procedures would produce no significant shifts of fluids or electrolytes (Toledo et al. 2001). The use of senna has not been reported in dogs before colonoscopy. The objectives of this study were to evaluate the effects of senna on selected clinicopathologic analytes, to evaluate the safety of senna for use as a bowel-cleansing agent, to determine the efficacy of senna compared with the standard

PEG bowel preparation in healthy adult dogs.

Materials and Methods

In this study, 20 adult mongrel dogs with an average weight of 22.05 ± 2.23 kg were used. The dogs were examined for two weeks in terms of health, appetite, and disease, and antiparasitic drug (Caniverm, Bioveta, Czech Republic) as well as polyvalent (DHPPiL, Canvac, Czech Republic) and rabies (Canvac, Czech Republic) vaccines were administered. During these two weeks, dogs were fed with the standard dry commercial with 29% protein and 9-10% fat at 300 to 400 g per day, based on body weight. Then the dogs were divided randomly into four equal groups. Food intake was withheld 15 hours before the first laxative administration, but the water was free for dogs.

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 orogastric tube. Twenty minutes later a 20 ml/kg warm water enema was administered. PEG and enema administration were repeated 4 h after the initial dosing. In the next morning, an additional warm water enema was performed prior to radiography and colonoscopy. It should be noted that before administration of laxative solutions in dogs, tranquilizers (acepromazine maleate plus ketamine hydrochloride) with minimal sedative effect were used.

The second group, instead of polyethylene glycol, received 20 mg/kg body weight of senna (Sena-graph, Iran Darouk, Tehran, Iran) 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 dose of the first and second groups plus enema, and the dogs in the fourth group received half the dose of PEG and senna plus enema.

Blood samples were collected from jugular vein prior to ingestion of laxatives (zero) and 1, 2, 5, 6, and 24 h after administration of solutions. All samples were processed on the day of collection. Serum concentration of total calcium, phosphorus, chloride, magnesium, Packed Cell Volume (PCV), total protein (TP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), the blood urea nitrogen (BUN) and creatinine were measured using a standard autoanalyser with veterinary software (BT-1500, Biotecnica Instruments, Italy). All of the above mentioned parameters were measured by Pars Azmun kits (Pars Azmun Inc., Iran). Sodium and potassium levels were measured by the flame photometric method (Corning, M410, United Kingdom). Packed cell volume was determined using hematology analyzer (BC-2800 Vet, Mindray, China). All dogs were examined for observation of possible adverse effects of laxative solutions up to two weeks after the end of the study.

The data obtained from hematological and biochemical tests were analyzed by repeated measures analysis of variance (ANOVA). On the other hand, comparison of different groups at any time was performed by one-way ANOVA. In cases where $p < 0.05$ resulted, a significant relationship was considered.

Results

Results of physical examination were normal before and up to two weeks after the end of study. All dogs accepted intuba-

tion and intragastric administration of the solutions. None of the dogs showed 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. The results of laboratory values of this study are summarized in Tables 1 and 2. Based on statistical analysis, time had a significant effect on the serum concentration of all measured parameters ($P<0.05$), with the exception of magnesium ($P>0.05$). Moreover, the interactions of time and group significantly affect serum levels of any variable evaluated ($P<0.05$), with the exception of phosphorous and BUN ($P>0.05$), which means that the groups are changing over time but are changing in different ways. So that, there were no significant differences among 5 groups in serum concentrations of all measured parameters ($P>0.05$).

As regards sodium concentration, significant differences were found between the 5 groups. So that mean values at hour 5 were significantly different between groups 4 and 1 ($P=0.01$), 4 and 3 ($P=0.05$) as well as between groups 1 and 2 ($P=0.05$). Also, mean values at hour 6 were significantly different between groups 1 and 2 ($P=0.01$), 1 and 4 ($P=0.001$), 2 and 3 ($P=0.01$) and 3 and 4 ($P=0.001$).

In this study, significant differences regarding ALT level in serum of dogs was found among the 5 groups. So that mean values at hour 6 were significantly different between groups 1 and 2 ($P=0.05$), and between groups 1 and 3 ($P=0.01$). Regarding AST serum concentration in the 5 groups of this study, there was a significant difference between 5 groups. So that mean values at hour 5 were significantly different between groups 4 and 1 ($P=0.05$) and 4 and 3 ($P=0.05$).

Nevertheless, the average of none of the measured parameters fell outside of the reference interval at each time point. However, mean values at hours 0 and 24 were not significantly different between groups for any parameters evaluated ($P>0.05$).

Discussion

Colonoscopic examination is the most effective method used to evaluate the colon. It has superior sensitivity and specificity as compared to contrast enema when evaluating mucosal abnormalities in the colon (Poyrazoglu & Yalniz 2015). Its success depends not only on the colonoscopist's skill but also on the colon cleansing (Lee et al. 2014). In this context, adequate preparation of the bowels is a principal step in the colonoscopic evaluation. Insufficient bowel cleansing either leads the colonoscopist to miss pathological lesions, or it serves as an obstacle to the therapeutic interventions required for the lesions that are found. This situation defers the procedure, and it results in the need to repeat the evaluation (Brahmania et al. 2012).

In the last several decades, sodium phosphate and polyethylene glycol have commonly been used as compounds for bowel cleansing. Regarding sodium phosphate, its ineligibility in patients with concomitant diseases such as renal failure, congestive heart failure, and cirrhosis hampers its extensive utility (Poyrazoglu & Yalniz 2015). Also, the unpleasant taste and the large volume of PEG lead to poor compliance with recommended regimens and result in patient dissatisfaction (Laiyemo et al. 2015). Senna is an herb indigenous to Africa, Ara-

Table 1. Mean of serum concentration of electrolytes in dogs receiving PEG and senna bowel preparation. PEG: Polyethylene glycol.

Variables (Units)	Groups	Time after first laxative administration (Hour) 0	1	2	5	6	24
Na (mEq/L)	1	141.8±0.86	142.0±0.63	143.0±0.54	146.6±0.51	148.6±0.24	141.60±0.68
	2	142.8±1.28	142.6±1.2	142.8±1.28	143.2±1.46	143.6±1.63	142.60±1.33
	3	141.8±1.15	141.8±1.15	142.6±1.03	145.6±0.60	148.8±0.86	142.80±1.16
	4	141.2±1.28	141.2±1.28	141.4±1.17	142.2±1.28	141.2±1.46	140.60±0.93
K (mEq/L)	1	4.10±0.12	4.34±0.05	4.50±0.07	4.56±0.07	4.16±0.11	4.12±0.12
	2	4.18±0.09	4.44±0.05	4.60±0.03	4.38±0.04	4.34±0.04	3.96±0.07
	3	4.20±0.12	4.42±0.10	4.62±0.11	4.64±0.15	4.32±0.07	4.16±0.09
	4	4.30±0.07	4.38±0.06	4.50±0.05	4.58±0.06	4.32±0.05	4.26±0.07
Cl (mEq/L)	1	109.2±0.58	108.2±0.58	107.2±0.58	108.6±0.51	109.8±0.66	110.2±0.73
	2	109.0±0.70	108.8±0.73	108.0±0.70	107.2±0.58	108.2±0.58	109.2±0.66
	3	109.0±0.70	108.0±0.70	107.2±0.58	108.2±0.58	109.2±0.58	110.0±1.0
	4	109.0±0.70	109.0±0.70	108.0±0.70	107.6±0.51	109.2±0.58	109.0±0.84
Ca (mg/dL)	1	9.38±0.14	9.22±0.13	9.08±0.14	9.28±0.15	9.30±0.13	9.44±0.14
	2	9.48±0.13	9.38±0.13	9.28±0.13	9.34±0.12	9.44±0.13	9.46±0.09
	3	9.38±0.15	9.24±0.17	9.14±0.18	9.08±0.20	9.24±0.15	9.42±0.13
	4	9.38±0.21	9.32±0.22	9.24±0.20	9.16±0.21	9.30±0.22	9.44±0.21
P (mg/dL)	1	3.53±0.26	3.27±0.24	3.44±0.23	3.47±0.24	3.74±0.25	3.52±0.31
	2	3.46±0.21	3.17±0.20	3.31±0.21	3.43±0.20	3.58±0.20	3.51±0.20
	3	3.52±0.19	3.21±0.19	3.35±0.19	3.44±0.19	3.61±0.19	3.53±0.20
	4	3.49±0.18	3.35±0.18	3.41±0.18	3.45±0.17	3.56±0.18	3.50±0.18
Mg (mg/dL)	1	1.78±0.05	1.71±0.05	1.69±0.05	1.66±0.05	1.60±0.05	1.78±0.04
	2	1.78±0.05	1.75±0.05	1.74±0.05	1.70±0.04	1.66±0.06	1.78±0.04
	3	1.78±0.06	1.77±0.06	1.74±0.06	1.70±0.06	1.66±0.06	1.75±0.06
	4	1.76±0.05	1.75±0.04	1.74±0.04	1.71±0.04	1.71±0.05	1.76±0.05

bia and India, and is mentioned in the traditional Islamic medicine as a remedy for many diseases. A species of plant vegetates in southern Iran and around the Persian Gulf (Rosenthal et al 2014). Although it is widely used in the treatment of constipation, there is no information about its efficacy and safety in bowel cleansing in dogs.

One of the aspects of studies on bowel preparation has been patient's acceptance and adverse events of oral laxatives. None of the dogs in this study had signs of vomiting, regurgitation, diarrhea, nausea and coughing as well as dermatologic symptoms up to two weeks after the end of study. On the other hand, it can be concluded that administration of senna and PEG for bowel preparation in dogs is safe. Similarly, adverse reactions were minimal in dogs receiving PEG for colon cleansing in two other studies and the most frequently encountered symptoms in both researches were nausea and vomiting (Richter & Cleveland 1989; Daugherty et al. 2008). Vomiting in dogs prepared with the lavage solution was eliminated when the solution was warmed to near body temperature prior to administration, rather than given cold. In human beings, metoclopramide has been used prior to administration of the solution to control nausea (Richter & Cleveland 1989). The absence of vomiting in dogs in the present study can be attribut-

Table2. Mean of serum biochemical and hematological concentration in dogs receiving PEG and senna bowel preparation. PEG: Polyethylene glycol.

		Time after first laxative administration (Hour)					
Variables (Units)	Groups	0	1	2	5	6	24
ALT (IU/L)	1	24.40±1.86	23.00±1.92	22.40±1.96	26.20±1.39	29.00±2.21	27.00±2.43
	2	25.40±2.04	24.40±1.81	23.60±1.63	22.40±1.80	21.80±1.98	26.00±2.00
	3	25.40±2.32	23.20±2.78	21.20±2.57	20.20±2.59	19.40±2.80	27.40±3.07
	4	26.40±2.01	25.40±1.44	24.80±1.53	23.20±1.69	22.60±1.69	27.20±1.56
AST (IU/L)	1	21.00±1.22	22.80±1.24	24.60±1.03	27.20±0.86	28.00±1.14	23.00±1.30
	2	20.40±1.36	21.40±1.36	22.80±1.46	24.40±2.01	25.00±2.17	20.80±1.69
	3	20.40±1.32	21.60±1.36	23.60±1.57	25.60±1.17	28.00±1.22	22.60±1.21
	4	20.60±.92	20.60±0.93	20.60±0.93	21.60±0.93	22.20±1.16	21.20±1.16
BUN (mg/dL)	1	19.20±1.36	19.20±1.36	18.80±1.28	18.00±1.41	17.60±1.40	17.20±1.66
	2	18.80±1.77	18.60±1.63	18.60±1.63	17.60±1.60	18.20±1.59	18.40±1.75
	3	19.00±1.30	18.80±1.36	18.20±1.20	18.00±1.05	17.20±1.20	16.80±1.46
	4	19.20±0.86	19.00±0.71	18.80±0.66	18.00±0.84	18.20±0.86	18.60±0.81
SCr (mg/dL)	1	1.35±0.08	1.29±0.08	1.26±0.08	1.21±0.07	1.18±0.07	1.26±0.06
	2	1.37±0.08	1.37±0.08	1.36±0.08	1.36±0.08	1.35±0.08	1.33±0.08
	3	1.36±0.09	1.31±0.08	1.26±0.07	1.20±0.06	1.22±0.07	1.27±0.07
	4	1.37±0.08	1.34±0.07	1.29±0.07	1.28±0.07	1.26±0.06	1.29±0.07
TP (g/dL)	1	6.30±0.29	6.06±0.29	6.08±0.32	5.90±0.31	6.02±0.32	6.40±0.31
	2	6.26±0.25	6.26±0.25	6.20±0.25	6.14±0.26	6.06±0.25	6.30±0.27
	3	6.34±0.23	6.16±0.24	6.06±0.24	5.96±0.22	6.08±0.20	6.42±0.25
	4	6.34±0.24	6.28±0.21	6.26±0.22	6.18±0.22	6.14±0.21	6.38±0.27
PCV (%)	1	44.10±1.38	43.84±1.39	43.64±1.40	43.94±1.39	44.00±1.35	44.28±1.36
	2	43.68±1.33	43.66±1.35	43.58±1.33	43.54±1.33	43.52±1.32	43.70±1.34
	3	43.94±0.77	43.80±0.78	43.66±0.78	43.68±0.73	43.92±0.75	44.16±0.72
	4	43.92±1.08	43.90±1.08	43.80±1.08	43.70±1.08	43.78±1.07	43.92±1.06

ed to anti emetic effect of acepromazine used for sedation prior to administration of the solutions. Nevertheless, a major complication occurred in the dog was fatal aspiration pneumonia after vomiting PEG. It was suspected that decreased gag and cough reflexes associated with tranquilization contributed to the development of the fatal aspiration. Aspiration of vomited PEG has been reported in humans. It has been postulated that a toxic-allergic pulmonary edema develops in these cases (Leib et al. 2004).

Even systemic toxicity of repeated intravenous injections of a high dose of PEG in dogs is low, and alterations produced are reversible (Li et al. 2011). It is expected that PEG exert its full osmotic effect with fewer side effects (such as bloating and flatulence) than the nonabsorbable sugar laxatives, as there is no fermentative production of intestinal gas (Katelaris et al. 2016).

To the authors' knowledge, there is no study which evaluates adverse effects of senna in dogs while numerous studies have been conducted on the assessment of the side effects of the senna in humans. Tolerance to the given regimen and optimal compliance of the patients to the dosing used play a crucial role in successful bowel cleansing. The incidence of adverse reactions was similar in human beings that received senna or PEG; patients who received senna experi-

enced significantly less nausea and vomiting, but more abdominal pain. The regimen combining half doses of PEG-ES and senna provides acceptable patient tolerance, with less abdominal pain compared with high-dose senna. Therefore, they concluded that an oral high dose of senna is a valid alternative to standard PEG for outpatient colonoscopy preparation (Kelly et al. 2012; Santos-Jasso et al. 2017). Also, the senna regimen is superior to the sodium phosphate regimen in terms of application compliance and its side effects (Poyrazoglu & Yalniz 2015). In addition, in a study in Iran, senna preparation was overall better tolerated than PEG, so that subjects who received senna had significantly less vomiting, nausea, and headache, but significantly more abdominal pain (Shavakhi et al. 2011).

However, some old studies have reported side effects of long-term abuse of senna or working in senna-based healthcare manufacturing factories. Presumably, its side effects such as hepatitis, cachexia, tetany, clubbing, and hypertrophic osteoarthropathy, as well as studies reporting its inadequate efficiency, hampered its utility for bowel cleansing (Poyrazoglu & Yalniz 2015).

Based on the result of this study, senna and PEG had no significant effects on serum hematological and biochemical parameters of dogs. However, transient fluctuations of some serum electrolytes and biochemical parameters were not clinically significant and were within the normal ranges. Thus this study indicates that senna and PEG can be safely administered in dogs for bowel preparation. It appears that PEG is safe for use in the dogs, because no change in blood chemical values, PCV, osmolality, or total protein concentration was found (Burrows 1989). Also, in a comprehensive study on the safety of the PEG as colon cleansing agent in dog, no statistically significant changes were found in plasma concentration of calcium, phosphorous, magnesium, sodium, potassium, chloride, bicarbonate, anion gap, venous pH, total protein, PCV, osmolality as well as body weight (Daugherty et al. 2008). Due to PEG electrical neutrality and osmolarity similar to the plasma, there is neither exchange nor loss of water or ions. Lack of any effect on intravascular volume, and negligible effects on serum electrolyte balance with no change in the appearance of colonic mucosa constitute the main advantages (D´souza & Shegokar 2016).

Unfortunately, no other studies in the veterinary literature are available regarding biochemical or hematological changes due to senna administration in dogs for comparison to ours. In human medicine, when compared with respect to laxative 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 (Bektas et al. 2005). Changes in serum electrolyte concentrations can occur with use of any laxative, but with senna there is no risk of hyperphosphatemia and its clinical consequences, as can occur when phosphate-containing agents are used for bowel preparation. Thus, senna is safer when used routinely for bowel cleansing (Radaelli & Minoli 2002).

The aim of measuring BUN, creatinine, ALT and AST in the present study was to evaluate the possible side effects of the PEG and senna on kidney and liver respectively. However, results of this study showed that senna or PEG administration in dogs has no adverse effect on liver and kidney functions. Long term treatment of chronic con-

stipation in children with PEG induced minor elevation of ALT and AST levels during the study in some patients. The elevation was only a few points above reference range and completely resolved in all. No symptoms or signs of liver disease were present in these patients. They concluded that the transient abnormal aminotransferase levels were clinically insignificant and unrelated to PEG treatment (Pashankar et al. 2003).

Conclusion: Nevertheless, due to its suitable tolerability, requirement of a shorter period of time in colon cleansing, no adverse effects and lower cost, we recommend the use of senna in bowel preparation prior to colonoscopy in dogs.

Acknowledgments

This project was performed under grant of the Research Council, Shahid Chamran University of Ahvaz.

Conflicts of interest

The author declared no conflict of interest.

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مجله طب دامی ایران، ۱۳۹۸، دوره ۱۳، شماره ۲، ۱۸۵-۱۷۵

تأثیر آماده‌سازی روده با پلی‌اتیلن گلیکول و سنا در سگ بر برخی پارامترهای بیوشیمیایی و هماتولوژی سرم

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(دریافت مقاله: ۱۹ دی ماه ۱۳۹۷، پذیرش نهایی: ۲۶ اسفند ماه ۱۳۹۷)

چکیده

زمینه مطالعه: کولونوسکوپی روش ترجیحی برای تشخیص بیماری‌های بزرگ روده در سگ‌ها است. پلی‌اتیلن گلیکول معمول‌ترین ملین برای پاک کردن کولون است. در طب سنتی، سنا به عنوان یک ملین و کمک به درمان یبوست مورد استفاده قرار گرفته است.

هدف: هدف از انجام این مطالعه ارزیابی بی‌خطر بودن استفاده از سنا به عنوان یک ماده جایگزین یا کمکی برای پلی-اتیلن گلیکول در سگ‌ها با استفاده از آزمایشات هماتولوژی و بیوشیمیایی بود.

روش کار: برای این منظور، ۲۰ قلاده سگ از نژادهای مخلوط به طور تصادفی برای دریافت یکی از چهار رژیم آماده‌سازی روده شامل پلی‌اتیلن گلیکول، سنا یا ترکیب آن‌ها به همراه تنقیه اختصاص داده شد. غلظت سرمی سدیم، پتاسیم، کلسیم تام، فسفر، کلر، منیزیم، هماتوکریت، پروتئین تام، آلانین آمینو ترانسفراز، آسپارتات آمینو ترانسفراز، ازت اوره خون و کراتینین در زمان‌های صفر، ۱، ۲، ۵، ۶ و ۲۴ ساعت پس از اولین تجویز محلول‌های ملین اندازه‌گیری شدند.

نتایج: تجزیه و تحلیل آماری نشان داد که محلول‌های پلی‌اتیلن گلیکول و سنا تأثیر معنی‌داری بر میزان غلظت سرمی پارامترهای مورد بررسی نداشت ($P>0/05$). با وجود تغییرات معنی‌دار در غلظت سرمی تمام پارامترهای اندازه‌گیری شده بر اساس زمان نمونه‌گیری در همه گروه‌ها، نتایج حاصله در محدوده طبیعی آن‌ها قرار داشت ($P<0/05$).

نتیجه‌گیری نهایی: این اولین ارزیابی سلامت آماده‌سازی روده با استفاده از سنا در سگ است. این مطالعه نشان داد که استفاده از پلی‌اتیلن گلیکول و سنا برای پاک‌کردن کولون در سگ‌ها هیچ تأثیر ناهنجاری بر غلظت پارامترهای بیوشیمیایی و الکترولیتی سرم آن‌ها ندارد.

واژه‌های کلیدی:
کولونوسکوپی، سگ، داروهای ملین، پلی‌اتیلن گلیکول، سنا

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