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ORIGINAL ARTICLE

A retrospective comparison of the efficacy of sennoside A + B calcium solutions and polyethylene glycol solutions for bowel preparation prior colonoscopy

Kolonoskopi öncesi bağırsak hazırlığında sennosid A + B kalsiyum solüsyonları ile polietilen glikol solüsyonlarının etkinliğinin retrospektif karşılaştırması

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ABSTRACT • **Background and Aims:** Colonoscopy is a widely used method for diagnosing colorectal diseases. Its diagnostic accuracy largely depends on the quality of bowel preparation. Two commonly used bowel cleansing agents are sennoside A + B calcium and polyethylene glycol solutions. This study aims to compare the effectiveness of these two agents using different bowel preparation scoring systems. **Materials and Method:** Colonoscopies performed by a single endoscopist at a tertiary center between February 2024 and April 2025 were retrospectively evaluated. Patients received either polyethylene glycol or sennoside A + B calcium solutions for bowel preparation, based on informed patient preference. Bowel cleansing quality was assessed segmentally using the Boston bowel preparation scale, the Ottawa bowel preparation scale, and the Chicago bowel preparation scale. **Results:** A total of 114 patients were included in the study. The polyethylene glycol group (n = 53) achieved significantly higher scores on the Boston bowel preparation scale and the Chicago bowel preparation scale, and lower (better) scores on the Ottawa bowel preparation scale, indicating superior bowel cleansing quality compared to the sennoside group (n = 61). A strong negative correlation was observed between the Boston and Ottawa bowel preparation scales, while a strong positive correlation was found between the Boston and Chicago bowel preparation scales. The Ottawa and Chicago bowel preparation scales also demonstrated a strong negative correlation. No statistically significant correlations were found between the number of previous colonoscopies or the time since the last procedure and any of the three bowel preparation scales. **Conclusion:** This study demonstrated that polyethylene glycol solutions provide significantly better bowel cleansing quality compared to sennoside A + B calcium, as evaluated using three strongly correlated bowel preparation scales. The findings suggest that lower body mass index and previous colonoscopy experience may be associated with improved bowel preparation, possibly due to better patient adherence. While both agents are commonly used in clinical practice, polyethylene glycol solutions may be the preferred option, especially in patients who have undergone prior colonoscopy with inadequate bowel cleansing.

Key words: Colonoscopy, bowel preparation, polyethylene glycol, sennoside A + B calcium

ÖZET • **Giriş ve Amaç:** Kolonoskopi, kolorektal hastalıkların tanısında yaygın olarak kullanılan bir yöntemdir. Bu yöntemin tanısal doğruluğu büyük ölçüde bağırsak hazırlığının kalitesine bağlıdır. Yaygın olarak kullanılan iki bağırsak temizleme ajanı sennosid A + B kalsiyum ve polietilen glikol solüsyonlarıdır. Bu çalışma, farklı bağırsak hazırlık skorlama sistemleri kullanılarak bu iki ajanın etkinliğini karşılaştırmayı amaçlamaktadır. **Gereç ve Yöntem:** Şubat 2024 ile Nisan 2025 tarihleri arasında üçüncü basamak bir merkezde, tek bir endoskopist tarafından gerçekleştirilen kolonoskopiler retrospektif olarak değerlendirildi. Hastalar, bilgilendirilmiş tercihleri doğrultusunda polietilen glikol veya sennosid A + B kalsiyum solüsyonu ile bağırsak hazırlığı aldı. Bağırsak temizliği kalitesi, Boston bağırsak hazırlık skalası, Ottawa bağırsak hazırlık skalası ve Chicago bağırsak hazırlık skalası kullanılarak segmental olarak değerlendirildi. **Bulgular:** Toplam 114 hasta çalışmaya dahil edildi. Polietilen glikol grubunda (n = 53), Boston bağırsak hazırlık skalası ve Chicago bağırsak hazırlık skalası skorları anlamlı derecede daha yüksek; Ottawa bağırsak hazırlık skalası skorları ise daha düşük (daha iyi) bulundu. Bu, polietilen glikolün sennosid grubuna (n = 61) kıyasla üstün bağırsak temizliği sağladığını göstermektedir. Boston ve Ottawa bağırsak hazırlık skalaları arasında güçlü negatif korelasyon, Boston ve Chicago bağırsak hazırlık skalaları arasında ise güçlü pozitif korelasyon saptandı. Ottawa ve Chicago bağırsak hazırlık skalaları arasında da güçlü negatif korelasyon gözlendi. Önceki kolonoskopi sayısı ve son kolonoskopiden geçen süre ile üç bağırsak hazırlık skalası arasında istatistiksel olarak anlamlı bir ilişki bulunmadı. **Sonuç:** Bu çalışma, üç farklı ve birbiriyle güçlü korelasyon gösteren skorlama sistemi kullanılarak değerlendirildiğinde, polietilen glikol solüsyonlarının sennosid A + B kalsiyuma göre anlamlı şekilde daha iyi bağırsak temizliği sağladığını göstermiştir. Bulgular, daha düşük beden kitle indeksinin ve önceki kolonoskopi deneyiminin daha iyi bağırsak hazırlığı ile ilişkili olabileceğini, bunun da muhtemelen hasta uyumunun daha yüksek olmasından kaynaklandığını düşündürmektedir. Her iki ajan da klinik uygulamada yaygın olarak kullanılsa da, özellikle daha önce kolonoskopi yaptırmış ve yeterli bağırsak temziliği elde edilememiş hastalarda polietilen glikol solüsyonları tercih edilebilir.

Anahtar kelimeler: Kolonoskopi, bağırsak hazırlığı, polietilen glikol, sennosid A + B kalsiyum

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INTRODUCTION

Colonoscopy is one of the most commonly employed techniques for the diagnosis of colorectal diseases and plays a crucial role in colorectal cancer screening. Early cancer detection is associated with a significant long-term reduction in both incidence and mortality rates of malignancy (1,2). The quality of colonoscopy is dependent on adequate bowel preparation, which directly impacts diagnostic accuracy (3). Johnson et al. reported that approximately one-quarter of colonoscopy procedures still have suboptimal bowel preparation (4). Similarly, inadequate preparation has been reported in Western countries at rates of up to 20% (5,6). Additionally, a recent survey of 64 Italian screening centers revealed that only 29% of centers met the minimum standard of achieving adequate bowel preparation in at least 90% of colonoscopies (7). Inadequate bowel preparation reduces the sensitivity of the procedure, prolongs examination time, increases the risk of anesthesia and procedure-related complications, and raises the likelihood of repeat procedures, thereby contributing to higher healthcare costs (8-11).

There are two bowel cleansing regimens of widespread use, such as sennoside A + B calcium and polyethylene glycol (PEG) solutions (12-15). The regimen containing PEG is still regarded as a gold standard for bowel preparation, particularly regarding minimal electrolyte disturbances. However, patients are exposed to an unpleasant taste as well as the ingestion of large volume of fluid (16). The sennosides A + B calcium solutions are activated by colonic bacteria, have a direct effect on intestinal mucosa increasing the rate of colonic motility, enhancing colonic transit, and inhibiting water and electrolyte secretion. Therefore, the sennoside A + B regimen may result in hypokalemia and atonic colon (13,17). In a recent study, Coskun et al. compared the effectiveness of sennoside-containing solutions and PEG solution in bowel preparation before colonoscopy was evaluated using the Boston bowel preparation scale (BPS), cecal intubation rate and duration, and polyp detection rate, and it was emphasized that sennoside-based solutions were more effective than PEG-containing solutions (18). Nevertheless, the optimal bowel cleaning regimen has not been defined yet. The present study aims to compare the effectiveness of these two agents using different BPSs.

MATERIALS and METHODS

Study Design and Setting

This retrospective comparative study was conducted at a tertiary referral center. Participants underwent colonoscopy for various indications, including constipation, diarrhea, abdominal symptoms, iron deficiency anemia, rectal (occult) blood loss, positive fecal occult blood test, colorectal cancer screening, altered bowel habits, surveillance of inflammatory bowel disease, polyp surveillance, unexplained weight loss, follow-up after previous abnormal colonoscopy findings, change in stool caliber or consistency, and suspected colonic tumors.

Patients who underwent complete colonoscopy by a single endoscopist (A. A.) between February 2024 and April 2025 were included if they received either polyethylene glycol (PEG) solution or sennoside A + B calcium solution for bowel preparation, and if sufficient data were available from colonoscopy reports and images (video and/or photographs) taken with written informed consent prior to the procedure.

Before the colonoscopy, patients were informed about available bowel preparation solutions during their visits to the gastroenterology outpatient clinic, and the final choice was based on patient preference. Although various agents are used in our clinic, including sennosid A + B calcium solution, sodium phosphate solution, PEG solution, and sodium picosulphate solution, only patients who received either sennoside A + B calcium or PEG solution were included in this study.

Patients were excluded if the colonoscopy was performed under emergency conditions due to active gastrointestinal bleeding or if they were hospitalized at the time of the procedure. Additional exclusion criteria, based on pre-procedural data from the hospital's electronic medical records, included; acute or chronic renal failure, chronic liver disease, decompensated heart failure, pregnancy, known electrolyte imbalances, neurological or psychiatric disorders, documented colonic obstruction, a history of abdominal surgery involving the intestinal tract, or insufficient available data.

Bowel Preparation

The sennoside A + B calcium group received two 250-ml bottles of senna solution, each containing 500 mg of sennosides, administered in split doses. The first bottle was given at 1:00 p.m. on the day before the procedure, followed by at least 1.5 liters of clear liquid. The second dose was given 8 hours later at 9:00 p.m., again followed by at least 1.5 liters of clear liquid.

The PEG group received 4 liters of PEG solution orally (either 236 g or 227.1 g polyethylene glycol 3350, depending on the formulation, along with sodium sulfate, bicarbonate, chloride, and potassium chloride in corresponding amounts). Two liters were consumed at 6:00 p.m. on the day before the colonoscopy (250 mL every 10 minutes), and the remaining two liters at 4:00 or 5:00 a.m. on the day of the procedure, at least five hours beforehand. The choice between different PEG formulations (236 g or 227.1 g) was based on patient preference, primarily influenced by availability and cost at the time of colonoscopy.

All patients were provided with standardized dietary restrictions, which were explained during outpatient visits. Colonoscopies were performed under sedation, depending on patient preference and anesthesiologist approval.

Data and Evaluation of Colon Cleansing

All colonoscopy procedures were performed with patients in the left lateral decubitus position, between 8:00 a.m. and 4:00 p.m., under sedation. Patients' age, sex, body mass index (BMI), and history of colonoscopy were recorded. If there was a history of colonoscopy, the number of previous colonoscopy and date of last colonoscopy were also noted.

Three validated scales were used for the evaluation of bowel cleansing quality: the Boston BPS, the Ottawa BPS, and the Chicago BPS, each applied segment-by-segment (Table 1) (15).

The Boston BPS was applied on a segmental basis, with a total score obtained by summing the scores of three segments. The total score ranges from 0 (very poor) to 9 (excellent). Scoring was performed after washing or suctioning. The colon was evaluated in three segments: right colon (including the cecum and ascending colon), transverse colon (including the hepatic and splenic flexures), and left colon (including the descending and sigmoid colon, and rectum). An adequate preparation was defined as a total Boston BPS score ≥ 6, with a score of ≥ 2 in each segment. The Ottawa BPS was also applied segmentally. The total score is the sum of individual segment scores and an overall fluid score, ranging from 0 (excellent) to 14 (inadequate). Scoring was performed before washing or suctioning. The colon was assessed in three segments; the right colon, the mid-colon, and the rectosigmoid colon. The Chicago BPS was used to evaluate each segment before (fluid component) and after (mucosal cleaning) washing or suctioning. The total score, obtained by summing the scores of all segments, ranges from 0 (unprepared) to 36 (excellent). Segments evaluated included: right colon (cecum to mid-hepatic flexure), transverse colon (mid-hepatic flexure to mid-splenic flexure), and left colon mid-splenic flexure to distal rectum). No predefined threshold for adequacy was provided for Ottawa BPS or Chicago BPS (15).

Table 1 Assessment scales of colon cleansing.

Scale of Colon Cleansing	Score	Explanation
Boston bowel preparation score (by colon segment)	0	Unprepared colon segment with mucosa not seen because of solid stool that cannot be cleared
	1	Portion of mucosa of the colon segment seen, but other areas of segment not well seen because of staining, residual stool, and/or opaque liquid
	2	Minor amount of residual staining, small fragments of stool, and/or opaque liquid, but mucosa of colon segment is well seen
	3	Entire mucosa of colon segment well seen, with no residual staining, small fragments of stool, or opaque liquid
Ottawa bowel preparation scale (by colon segment)	0	Excellent: Mucosal detail clearly visible, almost no stool residue; if fluid present, it is clear, almost no stool residue
	1	Good: Some turbid fluid or stool residue, but mucosal detail still visible without need for washing/suctioning
	2	Fair: Some turbid fluid of stool residue obscuring mucosal detail; however, mucosal detail becomes visible with suctioning, washing not needed
	3	Poor: Stool present obscuring mucosal detail and contour; a reasonable view is obtained with suctioning and washing
	4	Inadequate: Solid stool obscuring mucosal detail and not cleared with washing and suctioning
Chicago bowel preparation scale (by colon segment)	0	Unprepared colon segment with stool that cannot be cleared (>15% of mucosa not seen)
	5	Portion of mucosa in segment seen after cleaning, but up to 15% of the mucosa not seen because of retained material
	10	Minor residual material after cleaning, but mucosa of segment generally well seen
	11	Entire mucosa of segment well seen after washing
	12	Entire mucosa of segment well seen before washing or suctioning

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro-Wilk test. Non-normally distributed numerical data were presented as median with interquartile range (IQR). Categorical data were presented as counts (n) and percentages (%). Numeric variables were compared between the two study groups (PEG vs. sennoside) using the Mann–Whitney U test. Categorical data were compared using the Pearson Chi-square Test. The relationships between the three BPSs (Boston, Ottawa, and Chicago) were evaluated using Spearman's rank correlation analysis. Correlation coefficients (R) were used to assess the direction and the strength of the relationships. A p-value of < 0.05 was considered statistically significance level.

Ethical Considerations

The study was approved by the ethics committee of the Ankara Bilkent City Hospital (TABED 1-25-1328) on May 21, 2025 and was conducted according to the Declaration of Helsinki.

RESULTS

Figure 1 summarizes the study flow. After applying the inclusion and exclusion criteria, a total of 114 patients were included in the study (Figure 1). Table 1 summarizes the demographic and clinical characteristics of the two study groups. Patients in the PEG group had a slightly lower median BMI compared to those in the sennoside group (25.4 vs. 26.4 kg/m^2, p = 0.030). Prior colonoscopy experience was significantly more common in the PEG group (41.5% vs. 16.4%, p = 0.003). Other characteristics were statistically similar between the study groups (Table 2).

The PEG group achieved significantly higher scores on the Boston BPS (median 9.0 vs. 8.0, p = 0.005) and the Chicago BPS (median 33.0 vs. 32.0, p < 0.001), while having lower (better) scores on the

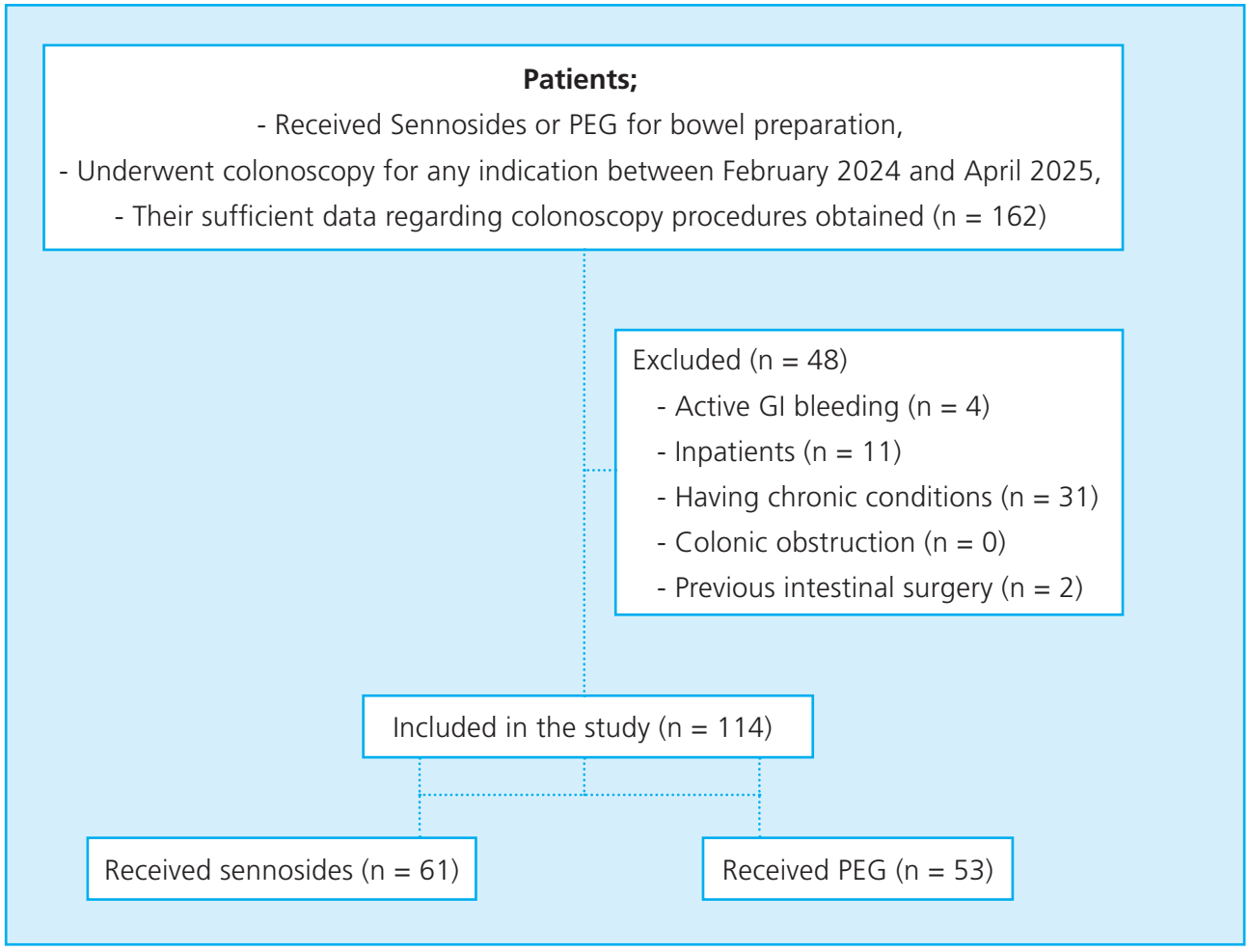

Figure 1 Flow diagram of the study.
GI: Gastrointestinal; PEG: Polyethylene glycol.

Table 2 Demographics and clinical features of the patients.

Variables	Sennoside (n = 61)	PEG (n = 53)	*p*
Age (year), Median (IQR)	58.0 (44.5)	49.0 (39.5 - 63.5)	0.079[a]
Gender, n (%)			
Female	32 (52.5)	25 (47.2)	0.573[b]
Male	29 (47.5)	28 (52.8)	0.573[b]
BMI (kg/m^2), Median (IQR)	26.4 (24.8 - 28.5)	25.4 (23.8 - 26.8)	**0.030**[a]
Presence of previous COL, n (%)	10 (16.4)	22 (41.5)	**0.003**[b]
Number of previous COL, Median (IQR)[c]	1.0 (1.0 - 1.0)	1.0 (1.0 - 1.0)	0.219a
Boston BPS score, Median (IQR)	8.0 (5.0 - 9.0)	9.0 (7.0 - 9.0)	**0.005**[a]
Ottawa BPS score, Median (IQR)	8.0 (6.0 - 12.0)	6.0 (4.0 - 7.0)	**< 0.001**[a]
Chicago BPS score, Median (IQR)	32.0 (15.0 - 33.0)	33.0 (33.0 - 34.0)	**< 0.001**[a]

[a]Mann-Whitney U Test was used.
[b]Pearson Chi-square Test was used.
[c]Comparison was made with the patients who had previously undergone colonoscopy (n = 32).
PEG: Polyethylene glycol, IQR: Interquartile range, BMI: Body mass index, COL: Colonoscopy, BPS: Bowel preparation scale.

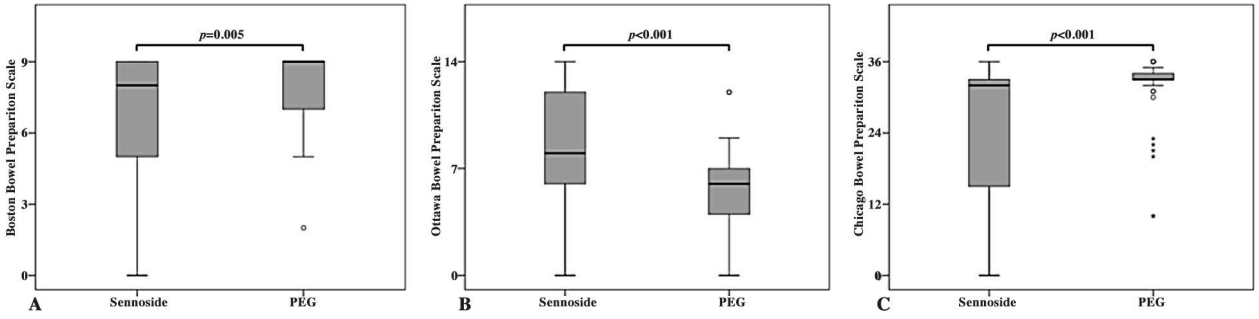

Figure 2 Box-plots of the (a) Boston, (b) Ottawa and (c) Chicago Bowel preparation scale scores in comparison between study groups.

Ottawa BPS (median 6.0 vs. 8.0, p < 0.001), indicating superior bowel cleansing quality than the Sennoside group (Table 2). These differences are visually represented in Figure 2, which displays box plots comparing the Boston, Ottawa, and Chicago BPSs between the two study groups (Figure 2).

The correlations between BPSs are presented in Table 2. A strong negative correlation was observed between the Boston and Ottawa BPSs (R = -0.687, p < 0.001), while the Boston and Chicago BPSs showed a strong positive correlation (R = 0.825, p < 0.001). The Ottawa and Chicago BPSs also demonstrated a significant negative correlation (R = -0.885, p < 0.001) (Table 3). These relationships are also illustrated in Figure 3 through scatter plots of the three BPSs.

Table 3 Correlations between bowel preparation scales.[a]

		Ottawa BPS	Chicago BPS
Boston BPS	R	-0.687	0.825
	p	**< 0.001**	**< 0.001**
	n	114	114
Ottawa BPS	R		-0.885
	p		**< 0.001**
	n		114

[a]Spearman correlation analysis was used.
BPS: Bowel preparation scale.

Table 3 shows the correlations between previous colonoscopy history (number and timing) and BPSs. No statistically significant correlations were found between the number of previous colonoscopies or the time since the last procedure and any of the three bowel preparation BPSs ($p > 0.05$ for all) (Table 4).

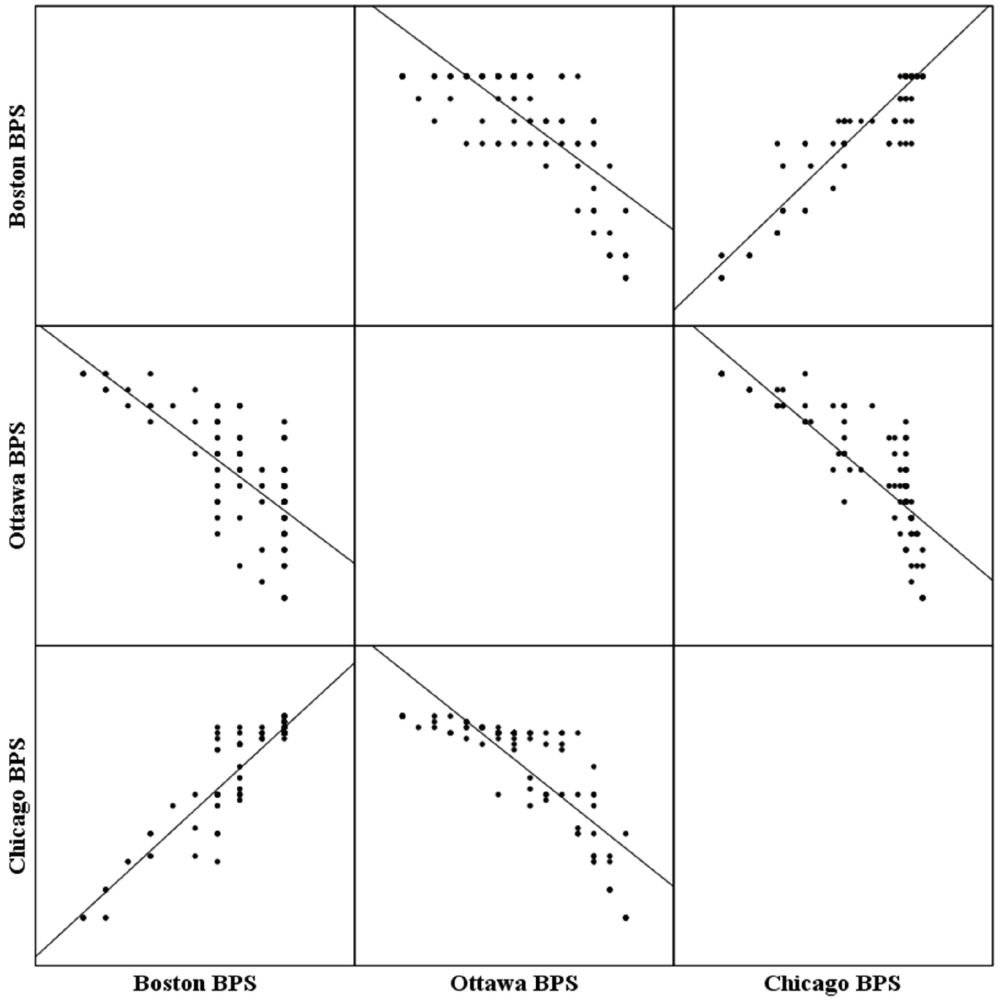

Figure 3 Scatter-plots of the bowel preparation scale scores.

Table 4 Correlations between number of previous colonoscopies, time from the last colonoscopy and bowel preparation scales.[a,b]

		Boston BPS	Ottawa BPS	Chicago BPS
Number of previous colonoscopies	R	-0.120	-0.069	0.120
	p	0.511	0.709	0.514
	n	32	32	32
Time from the last colonoscopy (month)	R	-0.079	0.279	-0.310
	p	0.669	0.122	0.084
	n	32	32	32

[a]Correlations were calculated with the data of the patients who had previously undergone colonoscopy.
[b]Spearman correlation analysis was used.
BPS: Bowel preparation scale.

DISCUSSIONS

The quality of colonoscopy depends on adequate bowel preparation, which directly impacts diagnostic accuracy (3). Inadequate bowel preparation prolongs examination time, increases the risk of anesthesia- and procedure-related complications, and raises the likelihood of repeat procedures, thereby contributing to higher healthcare costs (8-11). Inadequate bowel cleansing has been reported in 20-25% of patients who have previously undergone colonoscopy (4-6). This study aims to compare the effectiveness of sennoside A + B calcium and PEG solutions using different BPSs.

This study demonstrated significantly higher scores on the Boston BPS and the Chicago BPS, and lower (better) scores on the Ottawa BPS in the PEG group, indicating superior bowel cleansing quality compared to the Sennoside group. A strong negative correlation was observed between the Boston BPS and the Ottawa BPS, while a strong positive correlation was found between the Boston BPS and the Chicago BPS. The Ottawa BPS and Chicago BPS also demonstrated a strong negative correlation. No statistically significant correlations were found between the number of previous colonoscopies or the time since the last procedure and any of the three BPSs.

In a recently reported prospective study, split high-dose senna was found to be as effective as PEG for bowel preparation. The cecal intubation rate, polyp detection rate, total Boston BPS score, and the number of successful preparations were all higher in the senna group than in the PEG group. The split high-dose senna solution was found to be more effective than the PEG solution in the right and transverse colon, while the PEG solution achieved better cleansing scores in the left colon. Senna caused significantly less vomiting and nausea but significantly more abdominal pain compared to the PEG solution (18).

Hangartner et al., Børkje et al., Taşçı et al., and Shavakhi et al. compared PEG and various doses of senna for bowel preparation and found that the overall quality of bowel cleansing was statistically similar between the two groups. In these studies, adequate bowel cleansing rates were reported as 77%, 86%, 89%, and 88.2% in the senna group, and 79%, 92%, 89%, and 90.6% in the PEG group, respectively (19-22). In contrast, Radaelli et al. found that a high dose of senna solution was statistically more effective than PEG in patients undergoing colonoscopy (23). Additionally, Altinbaş et al. reported that although the best bowel cleansing scores were achieved with sennoside-based regimens, a higher proportion of adequate preparations was observed with PEG-based regimens (12).

In the current study, three different BPSs with strong correlations were used to evaluate bowel cleansing quality. The findings indicate that better bowel cleansing was achieved with PEG solutions compared to sennoside A + B calcium solutions. The distribution of age, gender, number of previous colonoscopies, and time since the last procedure was similar between the groups. Patients in the PEG group had a slightly lower median BMI than those in the sennoside group, and prior colonoscopy experience was significantly more common in the PEG group. Manukyan et al. reported that 26% of patients using senna experienced nausea, 6% vomiting, 52% abdominal pain, and 20% headache (13). Li et al. reported more nausea (58.5%), vomiting (19.5%), and less abdominal pain (2.4%) in patients using PEG solution (24). These adverse effects may help explain why PEG solutions are more frequently preferred by patients with prior colonoscopy experience. This preference, along with previous experience, may positively influence bowel preparation outcomes by improving medication adherence, dietary compliance, and overall tolerance, particularly in individuals with lower

BMI. Compared to previous studies, the superior bowel cleansing observed in the PEG group in our study may also be attributed to the comprehensive evaluation of the entire colon using three distinct and strongly correlated BPSs.

The strengths of this study include the use of real-life data, patient-driven selection of bowel preparation solutions based on optimal information, the implementation of a standardized diet, consistent performance of all procedures by a single endoscopist, and the systematic evaluation of bowel cleansing. The limitations of the study are its retrospective design, the relatively small sample size, and the lack of evaluation of patient tolerance and solution-related side effects.

In conclusion, this study demonstrated that PEG solutions provide significantly better bowel cleansing quality compared to sennoside A + B calcium, as evaluated using three strongly correlated BPSs. The findings suggest that lower body mass index and previous colonoscopy experience may be associated with improved bowel preparation, possibly due to better patient adherence. While both agents are commonly used in clinical practice, PEG solutions may be the preferred option, especially in patients who have undergone prior colonoscopy with inadequate bowel cleansing. Further prospective and randomized studies are needed to evaluate the quality of bowel cleansing, diagnostic yield, patient tolerance, and the impact of preparation-related adverse effects.

Ethics: *The study was approved by the ethics committee of the Ankara Bilkent City Hospital (TABED 1-25-1328) on May 21, 2025 and was conducted according to the Declaration of Helsinki.*

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