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Comparing hyoscine and drotaverine effects on colon in CT colonography

Research Article

Athanas D. Kristev[1], Nikolay V. Sirakov[2*], Damianka P. Getova[3], Vasil I. Katcarov[1], Vladimir N. Sirakov[2], Rumen S. Stefanov[4], Valentin I. Turiiski[1], Kichka G. Velkova[2]

[1] *Departments of Biophysics, Medical University - Plovdiv, 4002 Plovdiv, Bulgaria*

[2] *Image Diagnostics, Medical University - Plovdiv, 4002 Plovdiv, Bulgaria*

[3] *Pharmacology and Clinical Pharmacology Medical University - Plovdiv, 4002 Plovdiv, Bulgaria*

[4] *Social medicine and health management Medical University - Plovdiv, 4002 Plovdiv, Bulgaria*

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Abstract: Hyoscine and drotaverine effectiveness was compared for the purposes of achieving optimum distension following insufflation in CT colonography. The in vitro effects of hyoscine and drotaverine on tone and contractility of SM preparations isolated from different areas of human colon were studied by isometric registration of contractile activity. Both medications have a relaxing effect on SM preparations and inhibit their spontaneous contractions. The drotaverine-induced effects were reliably more marked than the hyoscine-induced ones. CT colonography was performed in 70 patients who were injected with equal doses of either hyoscine (n=32) or drotaverine (n=38). The degree of drug-induced distension in both groups was determined by measuring the lumen of the colon on a 2D reconstruction. In most colon areas the width of the distended lumen was greater in the drotaverine-treated patients. We concluded that drotaverine can be used as a means to facilitate colonic distension.

Keywords: *SM preparation • Hyoscine • Drotaverine • Human colon • CT colonography • Distension*

1. Introduction

One of the main requirements for quality CT colonography is the achievement of optimal distension of the colon [1,2]. Drugs causing relaxation of the colonic wall are administered for better distension [3]. Relaxation is achieved with hyoscine [3] or glucagon [4,5]. Comparative studies have demonstrated the abilities of these drugs to influence the level of colonic distension and have given certain advantages to hyoscine [6]. According to Taylor SA et al., (2003) hyoscine improves colonic distension during CT colonography and should be routinely administered where it is available [3]. Studies have been also published supporting the opinion that using these drugs to facilitate distension in CT colonography is ineffective, unjustified, and even useless [5-9]. The contradictions regarding hyoscine and glucagon effectiveness in CT colonography presuppose investigating other medications as potential relaxants of the colon, in vivo and in vitro.

Such investigations would provide a wider range of medications in CT colonography, which would make it possible to take into consideration the specific condition of each individual patient and perhaps some regional contractile peculiarities of the colonic muscles. Knowledge of that type is particularly important in cases that make impossible the administration of hyoscine or glucagons, because of the occurrence of adverse drug reactions such as allergy, rhythm disorders, or increased risk of developing high frequency tachycardia

* *E-mail: nsirakov@gmail.com*

and tachyarrhythmia [10]. We found only one article in the existing literature about application of drotaverine as a spasmolytic on patients with rectal balloon distension [11].

The aim of the study was to compare hyoscine and drotaverine effects on contractile activity of SMs isolated from the different anatomically distinguishable areas of the colon, and to evaluate quantitatively the effectiveness of both medications in achieving optimum distension in CT colonography.

2. Material and Methods

2.1. Drugs, chemicals, solutions

The drugs used were: hyoscine (buscolysin - Sopharma), drotaverine (no-spa - Chinoin, Budapest), acetylcholine (Sigma) and X prep (Mundifarma, GmbH).

The following Merck chemicals were used: NaCl, KCl, $CaCl_2$, $MgCl_2$, $NaHPO_4$, $NaHCO_3$, and glucose. The Krebs solution had the following composition (mM): NaCl - 120, KCl – 5.9, $CaCl_2$ - 2.5, $MgCl_2$ - 1.1, $NaHPO_4$ - 1.2, $NaHCO_3$ – 15.4 and glucose – 11.5.

The preparative solution contained NaCl:KCl:$CaCl_2$ in a ratio 27.2:1.1:1.0.

2.2. Smooth muscle (SM) preparations, patients

In the course of the investigation the following preparations were used: 8 taken from the ascending colon, 12 from the transverse, descending, and sigmoid colon, and 16 from the rectum. They were obtained during colon resections from male and female volunteer patients, aged 39 to 68. Any region of the surgical sample that had a break or a lesion in the muscular layer or mucosa was discarded. Consent about the donation of superfluous tissues was achieved in advance. All procedures were carried out in accordance with the standards set by the Declaration of Helsinki.

The tissue samples were pinned to a dissecting dish, containing preparative solution oxygenated in advance (around 2–4°C).

Smooth muscle strips (19–20 mm long x 1.5–1.6 mm wide) were cut parallel to the circular smooth muscle fibers.

2.3. Measurement of the mechanical activity of isolated SM preparations

The mechanical activity of SM preparations from the colon was measured isometrically. They were fixed at one end to a glass holder, and at the other to a Swema tensotransducer (Sweden) in a tissue bath. The SM samples were placed in Krebs solution (pH=7.4, t°=37°C), oxygenated by 95% O_2 and 5% CO_2. The initial mechanical tension was 10 mN. The experiments were performed about 45 min after the application of tension. During this period the SM strips were washed several times with fresh Krebs solution and their contractile activity was tested twice with 1.10^{-6} mol/l acetylcholine. To test the action of medications, the respective drug concentration was applied to the tissue bath. The concentration range used—from 2.10^{-5} mg/ml to 2.10^{-3} mg/ml—is comparable to the hyoscine and drotaverine dosage used in CT colonography.

The spontaneous and the drug-induced mechanical activity were registered with a Microtechna (Czech) amplifier and recorded with a Linseis (Germany) recorder. The pH of the solution was measured with a microcomputer pH-meter 6201 (Jenco Electronics, UK).

2.4. CT colonography, patients

The study involved 70 consecutive patients undergoing CT colonography, 27 men and 43 women with an average age of 58.08±1.86 years, chosen at random when they presented for investigation. Each patient signed an informed consent form in advance to take part in the present study, and permission was obtained from the Ethical Commission of the Medical University – Plovdiv prior to initiation of the study itself. Two groups were formed: the first was i.v. injected with 20 mg/ml of hyoscine (32 patients; average age 57.25±2.28; 37.5% men and 62.5% women), and the second one was similarly injected with 20 mg/ml - 2ml of drotaverine (38 patients; average age 58.76±2.87; 39.5% men and 60.5% women). No statistically significant differences were observed in the average ages of the patients in both groups, as well as in the male:female ratio in each group.

The patients started a clear fluid diet 24 hours prior to the CT colonography, and 7–8 hours prior to the investigation they did not ingest either food or water, after which they were prepared with X prep. Twenty minutes after injecting hyoscine or drotaverine, the colon was automatically insufflated with room air [12], until intracolonic pressure reached the value of 15 mmHg. After that, Omnipaque non-ionic contrast medium was introduced through a cannula at a dosage of 1 ml/kg body weight. The CT colonographic images were obtained by means of (Emotion) Siemens spiral CT with the following operation parameters: 110 kV, 140 mAs and 1-mm reconstruction interval.

Distension degree was investigated in the following 5 areas: ascending colon, transverse colon, descending colon, sigmoid colon, and rectum. The diameter of a relatively identical segment of each area of the

Table 1. Frequency and amplitude of spontaneous contractile activity of SM preparations, dissected from ascending colon, transverse colon, descending colon, sigmoid colon, and rectum. The comparison involved the values of each parameter of spontaneous SM contractions obtained from the different areas of the colon and was made with reference to the respective smallest value; * $P < 0.05$.

Parameter	Areas of colon				
	Ascending, n=12	Transverse, n=18	Descending, n=18	Sigmoid, n=18	Rectum, n=24
Frequency, min^{-1}	7.34 ± 0.22*	4.59 ± 0.22*	3.65 ± 0.14	4.33 ± 0.14*	3.12 ± 0.16
Amplitude, mN	3.26 ± 0.13	4.54 ± 0.26*	4.88 ± 0.16*	3.96 ± 0.25	4.30 ± 0.25

Table 2. Influence of hyoscine and drotaverine on the frequency of spontaneous contractions of SM preparations from ascending colon, transverse colon, descending colon, sigmoid colon and rectum. The comparisons were made with reference to the initial values of the frequencies from each area of the colon, admitted as 100% for each medication individually. * $P < 0.05$; ** $P < 0.01$.

concentration	ascending colon	transverse colon	descending colon	sigmoid colon	rectum
			Hyoscine		
controls	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00
2.10^{-5} mg/ml	100.00±0.00	98.93±1.63	95.03±2.38	100.47±0.47	98.94±1.94
2.10^{-4} mg/ml	98.73±1.20	95.73±2.57	94.15±2.18	99.67±0.33	95.80±2.64
4.10^{-4} mg/ml	99.48±2.55	94.70±2.73	94.77±3.55	101.92±1.86	93.39±1.36
8.10^{-4} mg/ml	93.83±1.90	90.48±4.76	91.50±1.83**	102.63±3.00	91.23±1.65*
$1.2.10^{-3}$ mg/ml	91.48±2.48*	78.25±13.80	90.95±1.53**	95.85±2.06	88.60±2.50**
2.10^{-3} mg/ml	89.80±3.14**	75.80±13.82	90.17±2.33**	94.17±1.54	84.45±2.94**
			Drotaverine		
controls	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00
2.10^{-5} mg/ml	93.75±0.75	95.80±2.38	99.45±1.10	98.50±1.42	98.89±2.12
2.10^{-4} mg/ml	81.18±2.84**	95.40±0.71	93.68±2.38	93.20±1.36	95.14±1.68
4.10^{-4} mg/ml	64.65±4.23**	86.10±3.17	83.75±3.10*	87.03±2.50	84.49±4.23*
8.10^{-4} mg/ml	48.85±4.17**	75.80±6.09	72.45±3.47**	77.17±3.34**	72.06±4.60**
$1.2.10^{-3}$ mg/ml	32.73±3.16**	64.12±10.38**	56.90±7.91**	51.38±4.29**	45.09±5.02**
2.10^{-3} mg/ml	12.43±4.20**	43.77±13.17**	39.63±11.42**	15.37±7.37**	17.16±5.24**

distended colon was measured individually for each patient in the supine and prone position using 2D multi-planar reconstruction views. The patients' data from each group formed a variation line, from which a mean ± S.E.M was determined for the different anatomical areas of the colon.

2.5. Statistical analysis

The quantitative variables obtained were expressed as mean ± S.E.M. The parameters of the spontaneous contractile activity (amplitude and frequency) were calculated as mean values of 10 consecutive contractions. The effects of the respective equimolar hyoscine and drotaverine concentrations for each type of SM preparation were compared individually using the ANOVA and Post Hoc Test Tukey HSD. The diameters of the different areas of distended colon (at 15 mmHg intracolonic pressure) of the hyoscine- or drotaverine-injected patients were compared using ANOVA and Mann-Whitney test. All the statistical analyses were evaluated by SSPS software.

3. Results

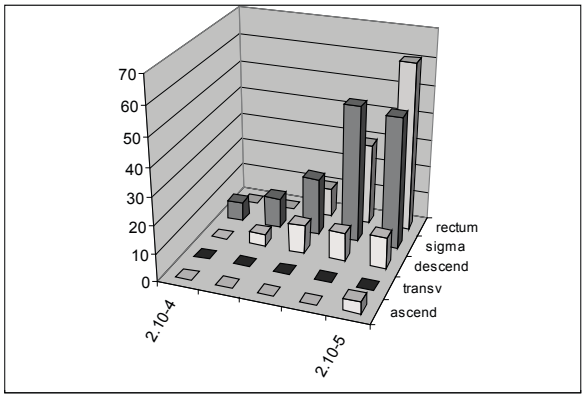
3.1. Character of spontaneous contractile activity

SM preparations, dissected from all parts of the colon studied, have phasic spontaneous contractile activity. The latter is specific for each individual area, characterized by difference in frequency and, magnitude (strength) (Table 1).

3.2. Effects of hyoscine and drotaverine on tone and spontaneous mechanic activity on of SM preparations from colon

The application of hyoscine and drotaverine influenced contractile activity of SMs isolated from different parts of the colon in a concentration-dependent manner.

Figure 1. Comparison of the strength of the isometric registered inhibitory effects of drotaverine against hyoscine for frequency of the spontaneous phase contractions of SM colon samples. Every bar shows the degree of dominance of the drotaverine induced effects against hyoscine induced effects. The absence of bars shows drug concentrations where there is no difference between the effects of the drugs.



3.3. Influence on the frequency of spontaneous contractions

Hyoscine had a mild influence on the frequency of spontaneous contractions of SM preparations from different parts of the colon. A significant reduction in frequency was registered in muscles from the ascending colon, descending colon and rectum in concentrations equal to and higher than 8.10^{-4} mg/ml. In the concentration range used, the medication had no effect on the frequency of contractions in preparations isolated from the transverse and sigmoid colon (Table 2).

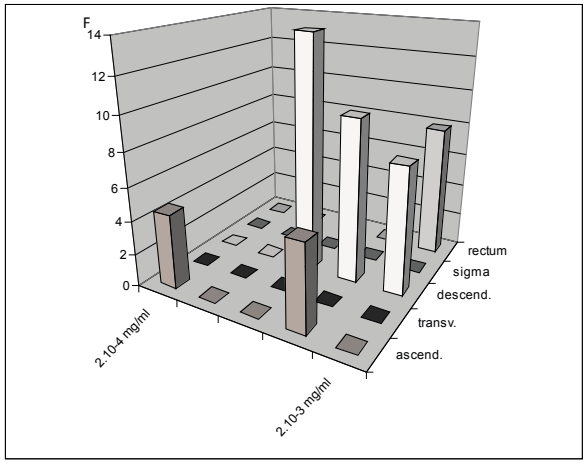
Drotaverine influenced the frequency of SM preparations from all areas of the colon. The reliable effects had different concentration thresholds for the different preparations. The drug-induced decrease in the frequency of spontaneous contractile activity is shown in Table 2.

The minimizing of spontaneous contraction frequency increased with the increase of drug concentrations. At low concentrations (2.10^{-5} mg/ml and 2.10^{-4} mg/ml), there was little difference in the effects of the two drugs. Upon increasing the concentrations, the difference in the strength of action of both drugs increased, the drotaverine-induced effects dominating in all cases. The concentrations at which statistically significant differences were registered between the amplitude of the effects of both spasmolytics are given in Figure 1.

3.4. Influence on the amplitude of spontaneous contractions

Both medications inhibited, although to a different degree, the strength of spontaneous contractions of SM preparations from colon. The effects of both spasmolytics are presented quantitatively in Table 3.

Figure 2. Comparison of the strength of the isometric registered inhibitory effects of drotaverine against hyoscine for amplitude of the spontaneous phase contractions of SM colon samples. Every bar shows the degree of dominance of the drotaverine induced effects against hyoscine induced effects. The absence of bars shows drug concentrations where there is no difference between the effects of the drugs.



The statistically significant differences in the effectiveness of the respective equimolar hyoscine and drotaverine concentrations in reducing the amplitude of spontaneous contractions are presented in Figure 2. The effect of drotaverine is dominant over that of hyoscine.

3.5. Influence on the tone of SM preparations

Hyoscine and drotaverine influenced the tone of SM preparations isolated from the colon. All effects were associated with relaxation and were concentration-dependent. Most marked was hyoscine action on the tone of preparations from the ascending colon. A tendency toward lowered drug effectiveness was observed in the direction from ascending colon to rectum (Table 4).

The relaxing effect of drotaverine was mildest in SM preparations from the ascending colon. A tendency towards an increase in the degree of relaxations caused by equimolar drotaverine concentrations was observed in the direction from the ascending colon to rectum. The influence of hyoscine and drotaverine on tone is given quantitatively in Table 4.

The drotaverine-induced reactions were more marked than the reactions induced by equimolar hyoscine concentrations for all types of SM preparations taken from colon. The statistically significant differences for each concentration used with each type of preparation are presented in Figure 3.

Table 3. Influence of hyoscine and drotaverine on the strength (amplitude) of spontaneous contractions of SM preparations from ascending colon, transverse colon, descending colon, sigmoid colon and rectum. The comparisons were made with reference to the initial values of the amplitudes from each area of the colon, given as 100% for each medication individually. * $P < 0.05$; ** $P < 0.01$.

concentration	ascending colon	transverse colon	descending colon	sigmoid colon	rectum
			Hyoscine		
controls	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00
2.10^{-5} mg/ml	97.30±3.06	98.22±2.50	94.82±2.56	80.83±4.38	98.25±2.34
2.10^{-4} mg/ml	91.15±1.92	86.63±4.06	89.78±3.95	59.27±6.34**	95.86±2.53
4.10^{-4} mg/ml	76.53±2.09**	77.88±5.22	76.17±3.88	41.28±8.62**	82.69±5.12
8.10^{-4} mg/ml	76.53±1.96**	64.12±9.85	65.02±4.34	24.68±5.96**	70.63±8.43*
$1.2.10^{-3}$ mg/ml	43.68±2.91**	47.82±14.33**	47.70±6.96**	14.72±5.02**	58.01±10.16**
2.10^{-3} mg/ml	20.90±3.54**	38.92±17.85**	29.68±7.13**	5.08±2.16**	50.10±10.63**
			Drotaverine		
controls	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00	100.00±0.00
2.10^{-5} mg/ml	93.75±0.75	96.40±1.45	96.13±2.38	89.68±3.99	95.83±2.89
2.10^{-4} mg/ml	81.18±2.84**	84.50±4.62	86.43±2.62*	70.32±7.11**	86.40±3.49
4.10^{-4} mg/ml	64.65±4.23**	67.32±10.41	64.58±2.92**	50.37±6.54**	68.45±6.90**
8.10^{-4} mg/ml	48.85±4.17**	57.82±12.48	40.13±2.74**	32.58±7.86**	55.23±6.79**
$1.2.10^{-3}$ mg/ml	32.73±3.16**	43.23±15.49**	21.97±1.56**	16.83±4.68**	32.76±7.93**
2.10^{-3} mg/ml	12.43±4.20**	36.25±18.24**	6.83±1.91**	6.37±3.38**	19.91±19.91**

Table 4. Decrease of tone of SM preparations from the ascending colon, transverse colon, descending colon, sigmoid colon, and rectum, caused by hyoscine and drotaverine. The value of each relaxation caused by the different concentrations was compared to an effect of 0.00±0.00 mN for each of the areas of the colon individually. * $P < 0.05$; ** $P < 0.01$.

concentration	ascending colon	transverse colon	descending colon	sigmoid colon	rectum
			Hyoscine		
2.10^{-5} mg/ml	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
2.10^{-4} mg/ml	0.00±0.00	0.05±0.03	0.00±0.00	0.00±0.00	0.00±0.00
4.10^{-4} mg/ml	0.30±0.04*	0.10±0.06	0.00±0.00	0.02±0.02	0.00±0.00
8.10^{-4} mg/ml	0.53±0.06**	0.28±0.06**	0.07±0.04	0.15±0.05	0.06±0.03
$1.2.10^{-3}$ mg/ml	0.85±0.06**	0.52±0.08**	0.30±0.06**	0.37±0.04**	0.28±0.05**
2.10^{-3} mg/ml	1.38±0.11**	0.97±0.07**	0.67±0.08**	0.60±0.08**	0.51±0.08**
			Drotaverine		
2.10^{-5} mg/ml	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
2.10^{-4} mg/ml	0.00±0.00	0.18±0.06	0.15±0.06	0.27±0.03*	0.09±0.04
4.10^{-4} mg/ml	0.13±0.05	0.47±0.04**	0.45±0.06**	0.55±0.05**	0.51±0.12**
8.10^{-4} mg/ml	0.65±0.09**	0.73±0.04**	0.90±0.12**	0.93±0.05**	1.35±0.09**
$1.2.10^{-3}$ mg/ml	1.30±0.04**	1.37±0.08**	1.45±0.12**	1.38±0.09**	1.68±0.14**
2.10^{-3} mg/ml	1.80±0.10**	2.00±0.18**	2.03±0.15**	1.95±0.11**	2.13±0.15**

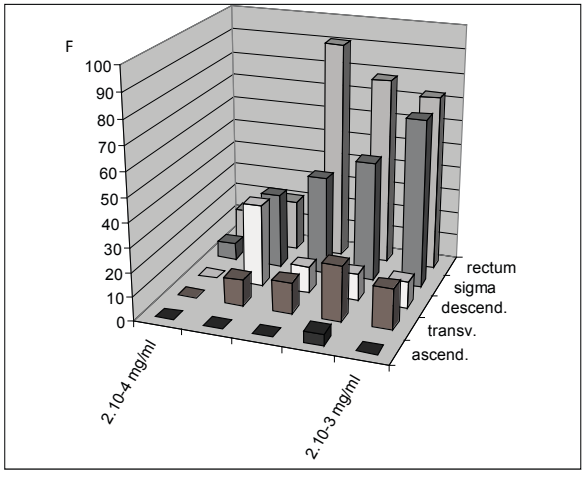
3.6. Influence of hyoscine and drotaverine on the degree of colon distension registered at identical values of intracolonic pressure

Our results showed certain differences in the degree of distension in the hyoscine- and drotaverine-injected patients from both groups, at one and the same intracolonic pressure, 15 mmHg.

The processing of the results with the purpose of finding significant differences in the lumen of identical areas of the colon in both groups of patients is presented in Table 5. The ascending colon was an exception, since no significant difference in the degree of distension was observed there (Table 5).

Similar dependencies between the widths of the lumen in hyoscine- and drotaverine-treated patients were observed in the prone position as well (Table 5).

Figure 3. Comparison of the strength of the isometric registered inhibitory effects of drotaverine against hyoscine for tonus of SM colon samples. Every bar shows the degree of dominance of the drotaverine induced effects against hyoscine induced effects. The absence of bars shows drug concentrations where there is no difference between the effects of the drugs.



4. Discussion

Our experiments showed that SMs from the human colon possess spontaneous contractile activity: a combination of contractions, relatively identical in duration and varying in amplitude. The SM contractions from the different areas of colon showed certain differences in their frequency and a tendency toward its reduction in the direction from ascending colon to rectum. Other authors have also observed a similar peculiarity [13]. The strength of spontaneous contractions is greatest in the transverse colon and smallest in the ascending colon.

Above certain threshold concentrations, hyoscine and drotaverine influenced the tone and parameters of spontaneous contractile activity of SM preparations. It was a one-way influence: drug-induced effects were manifested as reductions in the strength and frequency of contraction and relaxation. Significant differences were observed in the reactions of SM preparations isolated from different areas of the colon. These differences involved the extent of drug-induced effects, as well as the minimum drug concentrations at which these effects could be induced. This showed that there was a specific threshold of sensitivity to both medications for each parameter of the mechanical activity (frequency, strength, tone) and for each type of preparation.

Most sensitive to hyoscine was the tone of SM preparations from ascending colon. It was reliably relaxed at 4.10^{-4} mg/ml—a concentration, commensurate with the doses used in CT colonography. The threshold concentration in the distal zones of the colon gradually increased, and in sigmoid colon and rectum it reached $1.2.10^{-3}$ mg/ml, exceeding the doses used in CT colonography. The influence on the parameters of spontaneous phasic contractions differed in strength. The contractile activity of SM preparations from the proximal zones either did not change after hyoscine application (frequency), or was decreased at non-physiologically high concentrations (amplitude). In the remaining zones, the medication minimized to a greater extent the magnitude of spontaneous contractions, affecting their frequency to a lesser degree. Hyoscine action on SM mechanical activity is based on its cholinolytic effect. It blocks mostly peripheral pre- and postsynaptic muscarinic receptors [14], of which the M_2 and M_3 subtypes predominate in colonic SMs [15–18]. There is evidence of certain expression of M_1, M_4 and M_5 cholinergic receptors as well [19–21].

There are certain differences in the cholinergic control throughout the gastrointestinal tract [22,23]. This presupposes involvement of a different number of receptors in each type of SM preparation, as well as an acetylcholine-induced reaction differing in strength. That is probably why hyoscine-induced receptor blockage

Table 5. Influence of hyoscine and drotaverine on the degree of distension of the colon at identical intracolonic pressure (15 mmHg) in the supine and prone positions. The comparisons were made between the mean values of the diameter of colon in identical areas from the ascending colon, transverse colon, descending colon, sigmoid colon, and rectum for both groups of patients.

Drugs	Mean value of the diameter of colon [cm] in the area of:				
	Ascending	Transverse	Descending	Sigmoid	Rectum
			supine position		
Hyoscine	5.37±0.23	4.56± 0.16	3.91± 0.11	3.10± 0.17	5.14± 0.31
Drotaverin	5.88± 0.12	4.40± 0.10	4.56± 0.12	4.13± 0.11	6.69± 0.15
P	0.045	0.391	< 0.001	< 0.001	< 0.001
			prone position		
Hyoscine	5.21±0.23	3.87± 0.18	3.88± 0.11	3.94± 0.18	6.41± 0.27
Drotaverin	5.81± 0.11	4.09± 0.13	4.97± 0.14	4.73± 0.12	7.57± 0.11
P	0.052	0.127	< 0.001	< 0.001	< 0.001

has a different effect on the tone and spontaneous contractile activity of SMs from different zones of colon.

Drotaverine stimulates the synthesis of cAMP in tissues [24]. The increased cAMP level affects cellular processes inhibiting the contractile process in SMs [25,26]. The specific way of action of drotaverine includes reduction of the Ca^{2+} cytosolic level and/or desensitization of contractile apparatus [27,28]. Both processes are fundamental for the development of SM contraction/relaxation [29] in all types of SM tissues, involving both spontaneous phasic contractions and maintenance of SM tone. This satisfactorily accounts for the greater strength and lesser variability of relaxation reactions induced by drotaverine in SMs from different zones of colon. The comparison of the threshold concentrations, at which reliable effects on different parameters of contractile activity were registered, showed that almost all types of colonic SM preparations were more sensitive to drotaverine. This means that the difference in the relaxation efficacy of both medications is in favor of drotaverine. It is important to note that the drotaverine concentrations causing minimum reliable relaxation effects and reducing spontaneous contractile activity of SMs from all zones of the large bowel were commensurate with the therapeutic interval of the medication. Hyoscine had the same effect only in some of the zones, and not regarding all parameters characterizing mechanical activity.

The width of the distended lumen in both groups of patients achieved at intracolonic pressure of 15 mmHg was greater in the drotaverine-treated ones throughout almost the whole colon, and especially in its distal part. This is a sign of a better preliminary relaxation of intestinal muscles. The effects of the drugs on the mechanisms regulating contractile processes, and GI tract relaxation in particular, are too complex for a complete analysis. They are a combination of the immediate drug action on both SM cells and neuronal structures regulating the tone and motor activity of the tract by means of more than 25 types of neurotransmitters [30]. The effects of the enteric neuronal plexus on colon SMs are mediated by the action of these neurotransmitters on the respective receptors. The blockage of the latter does not exert a reliable influence on the character and propagation [31] of colonic bioelectric activity, which is accepted to cause motility. This evidence shows that neuronal structures have a relatively small contribution in generating spontaneous muscle contractions and determines the immediate influence of hyoscine and drotaverine on the intestinal wall SMs as a leading factor of the strength of drug action on colonic tone and motility.

The propagation of bioelectric potentials in colonic muscles is believed to occur through interstitial cells [32] that possess direct connections with SM cells [33]. It is postulated that the enhancement of cAMP has a negative influence on the frequency and propagation of slow waves, created from Cajal's cells [34]. This accounts for the fact that direct muscle relaxants, like drotaverine, can block them [33]. The inhibition of the propagation of bioelectric potentials, parallel to the immediate drotaverine action on the contractile apparatus of SM cells, decreases spontaneous contractions and relaxes colonic muscles. The results obtained explain the greater relaxation efficacy of drotaverine as compared to hyoscine, and the better distension it provides at identical values of intracolonic pressure, creating conditions for a better-quality CT colonography [9].

5. Conclusion

1. In vitro drotaverine and hyoscine caused concentration-dependent relaxation effects, specific for SM preparations from different levels of the colon, and inhibited spontaneous phasic contractions.
2. In equimolar concentrations, the strength of drotaverine-induced reactions was greater than that of the hyoscine-induced ones.
3. At identical values of intracolonic pressure (15 mmHg) the distension of the drotaverine-injected patients was reliably greater than that of the hyoscine-injected ones for most zones of colon (transverse colon excluded). The results obtained determine drotaverine as more appropriate than hyoscine in inducing relaxation to provide optimum colonic distension in CT colonography.

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