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Carbon dioxide *vs.* air insufflation in ileo-colonoscopy and in gastroscopy plus ileo-colonoscopy: a comparative study

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ABSTRACT

Introduction: insufflation with carbon dioxide (CO_2) during endoscopies compared to air is associated with a decrease in abdominal discomfort after the examination, because CO_2 is readily absorbed through the small intestine and eliminated by the lungs.

Aim: the objective of this randomized clinical trial was to assess the effect of CO_2 insufflation on pain and abdominal distension after an ileo-colonoscopy (I) and after an ileo-colonoscopy plus gastroscopy (I+G).

Material and methods: we included a total of 309 patients in the study and all endoscopies were performed under sedation with propofol. Two hundred fourteen patients underwent an I (132 with CO_2 / 82 with air) and 95 underwent an I+G (53 with CO_2 / 42 with air). Abdominal pain was studied at 10, 30 and 120 minutes of exploration and abdominal perimeter difference before and after the procedure.

Results: both in group I and in group I+G, the use of CO_2 translated into an average of abdominal pain significantly lower ($p < 0.05$). Similarly, a smaller increase in waist circumference was found among group I and group I+G, in patients where CO_2 was used ($p < 0.05$).

Conclusion: the insufflation of CO_2 instead of air during the performance of endoscopy significantly reduces the discomfort and abdominal pain after an ileo-colonoscopy and after a gastroscopy + ileo-colonoscopy.

Key words: CO_2 insufflation. Endoscopy. Ileo-colonoscopy.

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INTRODUCTION

In order to achieve an adequate visualization of the gastrointestinal mucosa during gastrointestinal endoscopy it is necessary to use gas insufflation. An average of 8 L of gas (air or CO_2) has been estimated to be required during colonoscopy (1). Many patients manifest discomfort in the gastrointestinal tract associated with air insufflation. In the last years different methods have been evaluated to improve patient tolerance to endoscopy and most of these complaints have been solved with the widespread use of sedation. Other methods as CO_2 insufflation have optimized tolerance.

Other authors have seen that the use of carbon dioxide (CO_2) during colonoscopy compared with room air, is associated with a decrease in pain after the procedure (2-7), because CO_2 has the peculiarity that it is rapidly absorbed from the gastrointestinal tract and is eliminated through the respiratory tract (this does not occur with air, which can only be removed through a natural way), achieving a rapid decompression of the gastrointestinal tract. This feature would allow the reduction of pain during and after the examination, and also of the need for sedation or anesthesia and of the exploration and recovery times (8).

Since Rogers did a small study evaluating the safety of CO_2 insufflation during endoscopy in 1974 (9), a number of authors have evaluated its use in gastrointestinal endoscopy: sigmoidoscopy (10), colonoscopy (1-7), ERCP (11,12) and recently double-balloon enteroscopy (13,14) and endoscopic submucosal dissection (15,16).

The primary aim of this randomized blinded clinical trial was to assess the effect of CO_2 insufflation on pain and abdominal distention after an ileo-colonoscopy (I) and after a gastroscopy plus ileo-colonoscopy (I+G).

MATERIAL AND METHODS

A team of six doctor-nurse groups participated in the study (four of medical endoscopists with more than 10 years

Table I. Baseline characteristics of both groups: mean (standard deviation)

	CO_2	Air	p
Ileo-colonoscopy (n = 214)	*(n = 132)*	*(n = 82)*	
Age (years)	59 (11.6)	59 (13.2)	0.955
Gender (M/F)	79/53	52/30	0.666
Weight (kg)	75.11 (14.5)	77.12 (16.2)	0.348
Height (cm)	168.10 (8.9)	168.09 (9.3)	0.992
BMI (kg/m^2)	26.4 (4.1)	27.1 (4.6)	0.263
Propofol (mg)	292.75 (113.5)	292.77 (115.2)	0.999
Ileo-colonoscopy + gastroscopy (n = 95)	*(n = 53)*	*(n = 42)*	*p*
Age (years)	55 (14.4)	54 (12.9)	0.852
Gender (M/F)	34/19	22/20	0.296
Weight (kg)	74.60 (15.5)	74.98 (15.1)	0.904
Height (cm)	169.08 (8.7)	166.24 (13.6)	0.221
BMI (kg/m^2)	26.1 (5.08)	26.5 (4.64)	0.638
Propofol (mg)	385 (108.6)	362.89 (135.4)	0.406

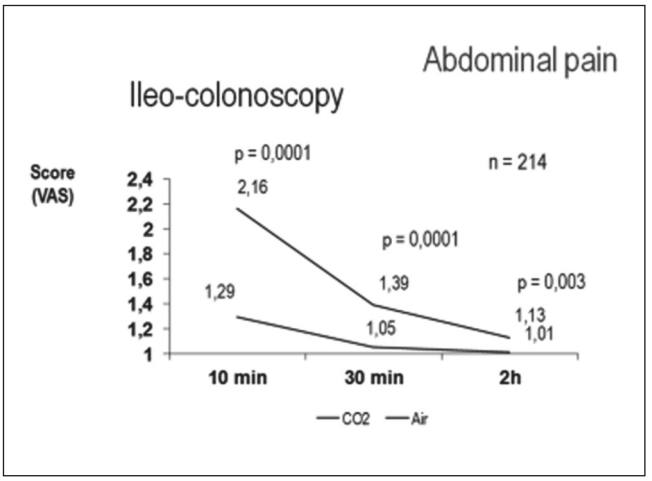

Fig. 1. Abdominal pain in the ileo-colonoscopy group.

of experience). We included a total of 309 patients who were undergoing a colonoscopy or gastroscopy plus colonoscopy. All patients signed, before the randomization, a specific informed consent for the study, which was approved by the hospital ethics committee. Exclusion criteria were: patients with a history of: abdominal surgery, inflammatory bowel disease, irritable bowel syndrome, severe chronic obstructive pulmonary disease or age over 80 or under 18 years old.

Of 309 patients, 214 (69.3%) underwent an I (132 were randomized to CO_2 insufflation and 82 to air) and 95 (30.7%) underwent an I+G (53 CO_2/ 42 air). All procedures were performed under sedation with propofol, administrated by bolus or by infusion pump controlled by the anesthetist. We used a CO_2 insufflator Olympus UCR (Endoscopic CO_2 Regulation Unit).

The study was done by filling a questionnaire which contained 20 variables: age, gender, body mass index, weight, height, type of endoscope used, abdominal circumference before and after the examination, doctor-nurse team, type of bowel preparation, cleaning of the colon, duration of exploration, polypectomy, presence or absence of diverticula, the necessity or not to modify the stiffness of the endoscope, the need or not of manual pressure required for advancing the scope, propofol dose given, the need to pull-back the scope or mobilize the patient for the procedure and tolerance to the test as abdominal pain.

Once the baseline characteristics of the patients were homogeneous, we specifically studied the following variables: abdominal pain, measured by visual analog scale (1 no-pain/10 worst pain) after 10 minutes, at discharge from the endoscopy unit (approximately 30 minutes) and 2 hours after by telephone contact; and second, the abdominal circumference difference before and immediately after the procedure, always measured at periumbilical level by the same nurse, who did not know which type of gas was used.

Statistical analysis

We used a parametric test (Student t test) for statistical analysis because the variables followed a normal distribution and we used the statistical program SPSS 13.0. Differences were considered significant between groups when p was less than 0.05.

RESULTS

The 4 groups were similar in age, gender, weight, height, BMI and dose of propofol (Table I). There were no differences in the type of bowel preparation, cleansing, duration of exploration, performing polypectomies, presence of diverticula or need to perform various maneuvers to advance the endoscope.

Considering patients who underwent an ileo-colonoscopy, at 10 minutes the score on the visual analog scale was an average of 1.29 in the CO_2 group *vs.* 2.16 in the room air group; at 30 minutes, an average of 1.05 *vs*. 1.39 respectively; and at 120 minutes, an average of 1.01 *vs.* 1.13 respectively. All differences were statistically significant. It also showed that, although the differences were greater at the end of endoscopy (at 10 minutes), at 2 h they remained statistically significant (p = 0.003) (Fig. 1).

In the other group (I+G group), the tolerance after 10 minutes was an average of 1.08 in the CO_2 group *vs*. 2.36 in the room air group; after 30 minutes, an average of 1.02 *vs*. 1.55 respectively; and after 120 minutes, an average of

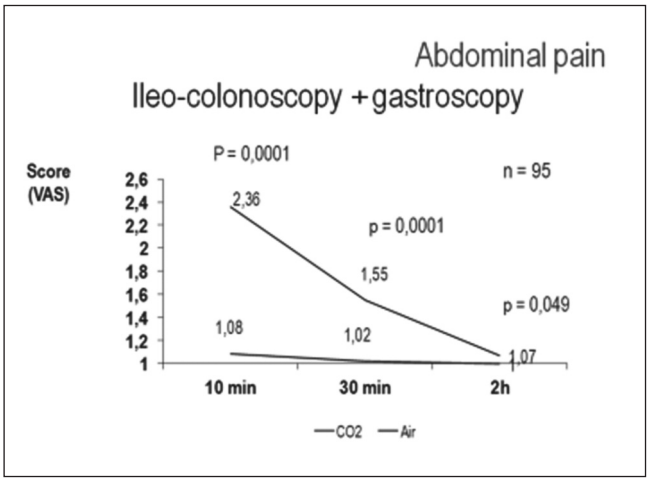

Fig. 2. Abdominal pain in the ileo-colonoscopy + gastroscopy group.

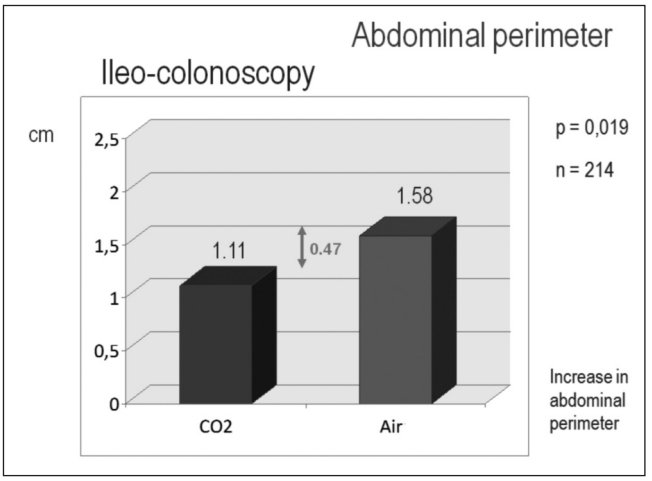

Fig. 3. Increased abdominal perimeter for the ileo-colonoscopy group.

1 *vs*. 1.07 respectively. All differences were statistically significant ($p < 0.05$) (Fig. 2).

In terms of increasing abdominal perimeter, in the I group, at the end of the endoscopy, we observed an average of 1.11 cm in the CO_2 group *vs*. 1.58 cm in the room air group ($p < 0.05$) (Fig. 3). In the I+G group at the end of the endoscopy, we observed an average increase in abdominal circumference of 0.81 cm in the CO_2 group *vs*. 2.07 cm in the room air group ($p < 0.05$) (Fig. 4). Also, the difference found in the increase of the abdominal perimeter comparing CO_2 and air in the group I + G is greater than in the ileo-colonoscopy group (Figs. 3 and 4).

No complications occurred during the study.

DISCUSSION

Several studies have shown that CO_2 insufflation instead of air during endoscopy can reduce discomfort after the procedure.

Many of the studies published have evaluated the degree of abdominal pain measured by visual analog scale (VAS), at different moments after the colonoscopy. For example, Stevenson et al. (2) published the results of a small study ($n = 56$), which assessed the effect of CO_2 insufflation *vs*. air in abdominal pain after a colonoscopy. A statistically significant difference ($p < 0.0005$) was observed 6 h after and the day after the procedure ($p = 0.01$) in the group that used CO_2 *vs*. the air group. Later, Bretthauer et al. (3) showed that CO_2 insufflation significantly reduced abdominal pain at the time, 3 h, 6 h and 24 h after a colonoscopy.

Some authors have postulated that CO_2 insufflation may reduce the need for sedation or anesthesia, but few studies have specifically analyzed the effect on sedation. In 2003, Church et al. (5) published the results of a test assessing the degree of abdominal pain immediately after colonoscopy in patients who had used CO_2 *vs*. air, showing less abdominal pain 10 minutes after the colonoscopy in the CO_2 group ($p < 0.05$) but no differences were related to sedation.

The study of Riss et al. (17) evaluated the efficacy of CO_2 insufflation after colonoscopy in patients with varying degrees of sedation and, in parallel, the degree of acceptance of screening programs for colorectal cancer (CCR). This study randomized 300 patients to undergo the procedure with CO_2 or air, showing less abdominal pain in the CO_2 group ($p < 0.01$) 15, 30 minutes and 6 h after the procedure. But carrying out the analysis according to the level of sedation of patients, we found no differences in the degree of personal satisfaction after the test, or the acceptance of CCR screening programs.

Moreover, given that CO_2 insufflation might theoretically involve retention of carbon dioxide and that this retention is favored by sedation (as it may cause hypoxemia and hypoventilation), Bretthauer et al. (6) random-

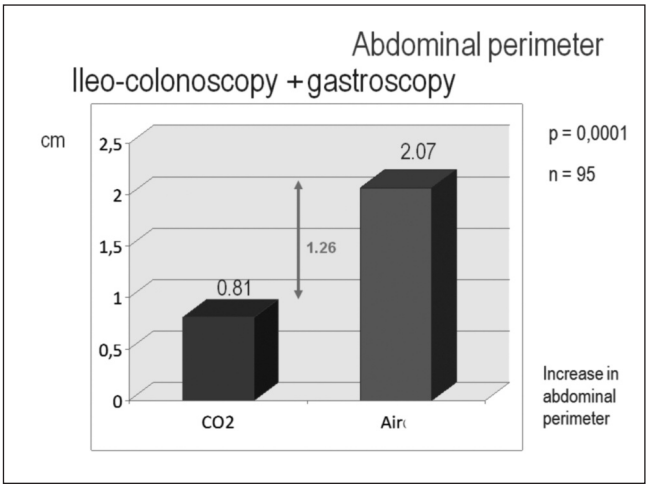

Fig. 4. Increased abdominal perimeter for the ileo-colonoscopy + gastroscopy group.

ized 103 patients to CO_2 or air insufflation in colonoscopy, collecting tidal CO_2 levels (CO_2 ET: End-tidal Carbon Dioxide) before, during and 10 minutes after the procedure. All patients received sedation with Pethidine and Midazolam. Lower degree of abdominal discomfort was observed in the CO_2 group compared to the air group, but no statistically significant differences were found in ET CO_2 in relation to sedation.

The rate of cecal intubation is an indicator of quality in colonoscopy. Studies have analyzed the colonoscopy exploration mean time using CO_2. A double-blind randomized clinical trial published by Yamano et al., in 2010 (7), evaluated the effect of CO_2 insufflation in colonoscopy without sedation on the partial pressure of CO_2 in the blood (pCO_2), on the volume of gas pumped, on the abdominal pain, and on the exploration time. They found lower pCO_2 levels compared with the reference range and reduced exploration time. They concluded that CO_2 insufflation reduces the examination time and enhances the rate of cecal intubation in colonoscopies without sedation. This suggests that the effects of CO_2 are more evident in longer explorations.

Another interesting aim in the evaluation of the use of CO_2 in endoscopy has to do with the degree of experience of the endoscopist. Some authors argue that cecal intubation rate is higher in more experienced endoscopists (18) and this helps to get better results. In our work it was not necessary to analyze the rate of cecal intubation because it was achieved in all patients included in the study, and ileocolonoscopy was performed in addition. A Japanese group conducted in 2009 a study that evaluated the efficacy of CO_2 insufflation in potentially difficult colonoscopies in relation to the level of experience of the endoscopist (18). Overall there was a beneficial effect of CO_2 *vs*. air on abdominal pain ($p < 0.001$) and subgroup analysis showed significantly lower pain score in the group of experienced endoscopist ($p = 0.023$).

Our study is the first to analyze the effect of CO_2 on abdominal pain and distention after an I and after an I+G. It seemed interesting to assess the effects of CO_2 insufflation compared to air for an exploration in which, after a complete colonoscopy, we explored the small bowel and therefore insufflated gas at this level.

We showed that abdominal pain score as well as the increase of abdominal perimeter were significantly lower in patients using CO_2 compared to air both in group I and group I+G.

CONCLUSION

CO_2 insufflation in endoscopic procedures can improve patient tolerance in relation to less abdominal pain and a significantly lower abdominal diameter. The use of CO_2 could be indicated in general and especially in long explorations and/or complicated ones, such as performing an ileo-colonoscopy and an ileo-colonoscopy + gastroscopy.

By improving patient tolerance to colonoscopy, we think that CO_2 insufflation may improve population adherence to screening programs.

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