

## Carbon dioxide insufflation during colonoscopy in deeply sedated patients

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Received: October 29, 2011 Revised: May 7, 2012

Accepted: May 26, 2012

Published online: July 7, 2012

### Abstract

**AIM:** To compare the impact of carbon dioxide (CO<sub>2</sub>) and air insufflation on patient tolerance/safety in deeply sedated patients undergoing colonoscopy.

**METHODS:** Patients referred for colonoscopy were randomized to receive either CO<sub>2</sub> or air insufflation during the procedure. Both the colonoscopist and patient were blinded to the type of gas used. During the procedure, insertion and withdrawal times, caecal intubation

rates, total sedation given and capnography readings were recorded. The level of sedation and magnitude of patient discomfort during the procedure was assessed by a nurse using a visual analogue scale (VAS) (0-3). Patients then graded their level of discomfort and abdominal bloating using a similar VAS. Complications during and after the procedure were recorded.

**RESULTS:** A total of 142 patients were randomized with 72 in the air arm and 70 in the CO<sub>2</sub> arm. Mean age between the two study groups were similar. Insertion time to the caecum was quicker in the CO<sub>2</sub> group at 7.3 min *vs* 9.9 min with air ( $P = 0.0083$ ). The average withdrawal times were not significantly different between the two groups. Caecal intubation rates were 94.4% and 100% in the air and CO<sub>2</sub> groups respectively ( $P = 0.012$ ). The level of discomfort assessed by the nurse was 0.69 (air) and 0.39 (CO<sub>2</sub>) ( $P = 0.0155$ ) and by the patient 0.82 (air) and 0.46 (CO<sub>2</sub>) ( $P = 0.0228$ ). The level of abdominal bloating was 0.97 (air) and 0.36 (CO<sub>2</sub>) ( $P = 0.001$ ). Capnography readings trended to be higher in the CO<sub>2</sub> group at the commencement, caecal intubation, and conclusion of the procedure, even though this was not significantly different when compared to readings obtained during air insufflation. There were no complications in both arms.

**CONCLUSION:** CO<sub>2</sub> insufflation during colonoscopy is more efficacious than air, allowing quicker and better caecal intubation rates. Abdominal discomfort and bloating were significantly less with CO<sub>2</sub> insufflation.

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**Key words:** Colonoscopy; Carbon dioxide; Air; Insufflations; Patient tolerance; Safety; Efficacy

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Singh R, Neo EN, Nordeen N, Shanmuganathan G, Ashby A, Drummond S, Nind G, Murphy E, Luck A, Tucker G, Tam W. Carbon dioxide insufflation during colonoscopy in deeply sedated patients. *World J Gastroenterol* 2012; 18(25): 3250-3253 Available from: URL: <http://www.wjgnet.com/1007-9327/full/v18/i25/3250.htm> DOI: <http://dx.doi.org/10.3748/wjg.v18.i25.3250>

## INTRODUCTION

Colonoscopy is now widely used as a screening tool for colorectal neoplasia screening. It is generally necessary to distend the colon adequately during colonoscopy to allow safe navigation and permit thorough inspection of the mucosa. Abdominal discomfort attributed to gas insufflation during the procedure can occasionally lead to significant patient discomfort. The perception of the procedure being relatively painless is hence of paramount importance. In order to make the procedure more comfortable, deep sedation with Propofol have been used<sup>[1]</sup>. Patients given Propofol had a more rapid onset of sedation and recovery. The use of carbon dioxide (CO<sub>2</sub>) instead of air has also been shown to reduce abdominal discomfort and pain in several randomized controlled trials<sup>[2-8]</sup>. These studies however utilized no or only minimal sedation when assessing the efficacy and safety of CO<sub>2</sub> in colonoscopy. The additional benefit of CO<sub>2</sub>, if any, in patients who are deeply sedated has not been gauged. We therefore embarked on this study to assess the true impact of CO<sub>2</sub> in deeply sedated patients undergoing colonoscopy.

## MATERIALS AND METHODS

This was a randomized, double blind study conducted over a period of 10 mo from May 2008 to March 2009. All patients undergoing screening and surveillance colonoscopy were invited to participate. Patients with previous colonic resections were excluded. Randomization was performed by whole sessions rather than individually by a clinical research coordinator. Sealed envelopes marked with either CO<sub>2</sub> or air insufflation was used. If the first patient on a given list was randomized to receive CO<sub>2</sub>, the air insufflation button was switched off and the CO<sub>2</sub> delivery system was activated by depressing a lever which was set up just above the CO<sub>2</sub> tank. The whole gas delivery system was intentionally located out of the view of the colonoscopist, the nurse assigned to grade the level of sedation and patient discomfort during the procedure as well as the patient. Air insufflation was delivered through standard means whereas CO<sub>2</sub> was delivered at a rate of 4 L/min with a pressure of 50 kilopascals using a standard CO<sub>2</sub> delivery system.

All colonoscopies were performed by experienced gastroenterologists or colorectal surgeons whom had each individually performed more than 5000 procedures. Patients received sedation in combinations of Propo-

fol, Midazolam and Fentanyl. This was administered by a trained nurse sedationist under the direction of the proceduralist. The total amount of sedation given was recorded at the end of each procedure. During the procedure, insertion and withdrawal times were recorded. Insertion time was defined as the time taken from the commencement of colonoscopy until the caecum was reached whilst the withdrawal time, time from the caecum up to the anus. The stopwatch was stopped during biopsies and polypectomies. Cecal intubation rates were also recorded.

End tidal CO<sub>2</sub> measurements were used to measure the CO<sub>2</sub> levels. Continuous measurement was possible using a nasal cannula which was connected to a capnograph. Capnography readings were charted at the 3 different time frames: at the commencement of colonoscopy, upon intubation of the caecum and at the conclusion of the procedure. The level of sedation during the procedure was assessed by the nurse sedationist using a visual analogue scale (VAS) (0-wide awake, 1-mild sedation/easy to rouse, 2-moderate sedation/unable to stay awake, 3-difficult to rouse) while the magnitude of patient discomfort was also assessed using a similar VAS (0-nil, 1-mild, 2-moderate, 3-severe).

At the conclusion of each procedure, the colonoscopists were asked to determine whether they thought the gas used was CO<sub>2</sub> or air. The patients were then observed in the recovery bay using a standardized post procedure recovery protocol. Prior to discharge from the unit, patients graded their level of discomfort and abdominal bloating using a similar VAS as described above.

Statistical analysis was performed using the Stata V10 Statistical software (StataCorp. 2007 College Station, TX, United States). *P* value < 0.05 was used to indicate statistical significance.

## RESULTS

A total of 150 patients participated in the study. Eight patients were excluded due to failure to give consent (3), history of previous colonic resection (3) and poor bowel preparation (2) leaving a total of 142 patients of which 72 were randomized in the air arm and 70 in the CO<sub>2</sub> arm. The two patient groups were of similar age with a mean of 59.97 (range: 22-88 years) in the air group and 58.26 (range: 22-84 years) in the CO<sub>2</sub> group. Of the 72 patients in the air group, 33 were male and 39 female whilst in the CO<sub>2</sub> group, 45 were male and 25 female (*P* < 0.05). The average insertion time was 9.88 min in the air group and 7.29 min in the CO<sub>2</sub> group (*P* = 0.0083). The average withdrawal times were 6.69 min and 7.29 min in the air and CO<sub>2</sub> groups respectively (*P* > 0.05). The caecal intubation rates were 94.4% in the air group and 100% in the CO<sub>2</sub> group (Table 1).

The amount of sedation given to patients during the procedure was similar in both groups. The level of sedation as assessed by a nurse during the procedure was 1.0 in the air group and 1.09 in the CO<sub>2</sub> group (*P* > 0.05).

**Table 1** Patient characteristics, procedure duration, sedation parameters, and capnographic readings with air and CO<sub>2</sub> insufflation during colonoscopy

	Air	CO <sub>2</sub>	P value
Total procedures	72	70	NS
Age (mean) (yr)	59.97	58.26	NS
Male:female ratio	33:39	45:25	NS
Insertion time (min)	9.88	7.29	0.0083
Withdrawal time (min)	6.69	7.29	NS
Cecal intubation rate (%)	94.4	100	0.012
Sedation used			
Propofol (mg)	185.97	184.14	NS
Midazolam (mg)	0.78	0.66	NS
Fentanyl (mg)	32.64	34.93	NS
Sedation (nurse assessment)	1.00	1.09	NS
Discomfort (nurse assessment)	0.69	0.39	0.0155
Pain (patient assessment)	0.82	0.46	0.0228
Bloating (patient assessment)	0.97	0.36	0.001
Capnography at commencement	18.53	20.21	NS
Capnography at caecum	15.1	19.28	NS

NS: Not significant.

Conversely, the discomfort level as assessed by the nurse (during the procedure) was 0.69 (air) and 0.39 (CO<sub>2</sub>) ( $P = 0.0155$ ) and post procedure by the patient 0.82 (air) and 0.46 (CO<sub>2</sub>) ( $P = 0.0228$ ). The level of abdominal bloating as assessed by the patient prior to discharge from the endoscopy unit was 0.97 (air) and 0.36 (CO<sub>2</sub>) ( $P = 0.001$ ) (Table 1).

Capnography readings were higher in the CO<sub>2</sub> group at commencement of colonoscopy, upon reaching the caecum and at the conclusion of the procedure (Table 1). This, however, was not statistically significant. There were 2 patients with Chronic Obstructive Airway Disease (COPD) in the air arm and 3 in the CO<sub>2</sub> arm ( $P > 0.05$ ). There were no complications observed with both the use of CO<sub>2</sub> or air. The accuracy of the colonoscopists in predicting the type of gas insufflation used was 73.6% in the air group and 54.7% in the CO<sub>2</sub> group.

## DISCUSSION

This prospective, randomized study has shown that insufflation of CO<sub>2</sub> during colonoscopy resulted in significantly reduced abdominal discomfort in deeply sedated patients. The rapid absorption of CO<sub>2</sub> from the colon resulted in less distension of the colon and therefore shorter procedural times. This was demonstrated with the quicker caecal insertion times in the CO<sub>2</sub> group compared to patients who were randomized to receive air insufflation. The caecal intubation rate in the CO<sub>2</sub> group was also better.

There have been numerous studies looking at the efficacy and safety of CO<sub>2</sub> in the gastrointestinal tract leading to a recently published systematic review on this subject by Dellon *et al*<sup>91</sup>. The authors concluded that CO<sub>2</sub> insufflation was associated with decreased post procedural pain and distension. One of the major drawbacks of this review which the authors concurred with is that 6 of the

9 randomized controlled trials were from the same group. None of the studies however looked at patients who were deeply sedated. With an increasing number of patients opting for a painless procedure especially with deep sedation, we attempted to address this question here.

The different colonoscopists performing the procedure may have arguably influenced the results as the more experienced practitioners would be expected to be more skilled. However, all colonoscopists involved in the study were experienced consultants with recognition in the practice of colonoscopy. No trainees/registrar were involved in performing the procedure. The insufflation of gas during colonoscopy was determined by sealed envelopes and several methods were employed in this study to ensure blinding of all parties involved. The gas coupling was hidden from view during the colonoscopic session thereby eliminating the possibility of unblinding if the changing of gas coupling was done after each patient. The usage of CO<sub>2</sub> or air was also silent further reducing the possibility of any audible sound from either the air or CO<sub>2</sub> delivery systems being heard by the colonoscopist or the nurse sedationist during the procedure. In addition, the possibility of the colonoscopist being able to determine the gas used by observing the distension of the colon during insufflation was not found to be a problem as seen in the accuracy of gauging the type of gas used at the procedure being 73.6% in the air group and 54.7% in the CO<sub>2</sub> group.

There have been concerns expressed with regards to use of CO<sub>2</sub> causing interference with metabolic homeostasis and respiratory complications in certain patient groups. Several studies have confirmed the safety of CO<sub>2</sub> insufflation although patients with COPD were excluded. We specifically did not exclude patients with COPD in this study (air: 2 *vs* CO<sub>2</sub>: 3). Although this study showed an increased level of capnography readings in the CO<sub>2</sub> group compared to air, this was not statistically significant. Moreover the baseline CO<sub>2</sub> was slightly higher than the air group (18.53 mmHg *vs* 20.21 mmHg). There were no respiratory complications seen. One of the major limitations though is that the measurement of CO<sub>2</sub> levels by capnography is not performed in a closed system and may have therefore not been very accurate. The level of CO<sub>2</sub> should ideally be measured by performing arterial blood gases. However, this was not thought to be appropriate given that the patients would have to undergo multiple arterial punctures during the procedure. We were also vigilant with the continuous monitoring of the CO<sub>2</sub> levels during the procedure although actual documentation was only done at 3 set time frames. Another drawback of the study is that there were a higher number of male patients compared to female patients in the CO<sub>2</sub> group which may have affected the result of bloating and pain level. However, the patient gender was found to not have any statistically significant difference.

In conclusion, the use of CO<sub>2</sub> insufflation during colonoscopy in deeply sedated patients was more efficacious than air, resulting in a quicker procedural time and

better patient tolerance with regards to less abdominal bloating and pain. It was also safe with no complications observed. It is recommended that CO<sub>2</sub> be considered for routine use in colonoscopy in deeply sedated patients to further increase patient comfort.

## COMMENTS

### Background

Colonic distention with gas during colonoscopy allows thorough inspection of the mucosa, at the expense of causing abdominal discomfort. In order to make the procedure more comfortable, apart from anaesthetic agents, the use of carbon dioxide (CO<sub>2</sub>) instead of air has also been shown to reduce abdominal discomfort and pain in several randomized controlled trials.

### Research frontiers

Previous studies however utilized no or only minimal sedation when assessing the efficacy and safety of CO<sub>2</sub> in colonoscopy. This study aimed to assess the true impact of CO<sub>2</sub> in deeply sedated patients undergoing colonoscopy.

### Innovations and breakthroughs

Use of CO<sub>2</sub> insufflation during colonoscopy in deeply sedated patients was not only safe, but more efficacious than air, resulting in a quicker procedural time and better patient tolerance with regards to less abdominal bloating and pain.

### Applications

It is recommended that CO<sub>2</sub> be considered for routine use in colonoscopy in deeply sedated patients to further increase patient comfort while allowing safe adequate colonic distention.

### Terminology

CO<sub>2</sub> insufflation is the distention of the colon with carbon dioxide gas during the performance of colonoscopy, to allow better visualization of the mucosa surface.

### Peer review

It is well known that patients who are not sedated or minimally sedated have significant benefits when CO<sub>2</sub> is used to insufflate the bowel. This study evaluated the effect of CO<sub>2</sub> on deeply sedated patients and further adds to the available data in the literature with regards to the its application in colonoscopy.

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S- Editor Gou SX L- Editor A E- Editor Zhang DN