Colonic distention with CO$_2$ insufflation. Impact on the patient’s discomfort in virtual colonoscopy studies.

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INTRODUCTION

Colorectal Cancer (CRC) is an ideal neoplasm for screening because most cases arise from preexistent lesions called adenomas. Lesions larger than 10 mm have 1% probability of being malignant and 8% probability of developing into cancer in 10 years, while lesions smaller than 5 mm have 0.08% probability of becoming malignant in that same period.

Several screening tests have been proposed and accepted by national and international consensus on CRC early detection. In recent years, virtual colonoscopy (VC), also known as Computed Tomographic Colonoscopy, has been added to the list of diagnostic procedures [1].

More than 20 years have passed since it occurred to Dr. David Vining that the computer technology he used to operate a flight simulator game on his personal computer might also allow him to navigate the large volume of data provided by spiral CT. However, the road to virtual colonoscopy has not been easy. Great technological advances, the development of new CT scanners and innovative image processing software, as well as variations in preparations, tag-
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...ging of residual fluid or residual stools were needed to achieve this goal.

Among various factors, two are of paramount importance for the good performance of a VC: colon cleansing and subsequent distention by room air or CO\(_2\) insufflation. Both, in turn, have a critical influence on patients’ expectations and acceptance of the diagnostic test.

In this paper, we will analyze the role of colonic distention with CO\(_2\) and its influence both on patients’ discomfort and the duration of the VC procedure in our daily practice.

**MATERIALS AND METHODS**

We evaluated two hundred patients who underwent a VC as ordered by their physician. VCs were performed with a 64-row multidetector CT scanner using 2-mm slice thickness, a 1-mm reconstruction interval, 120 kV and 50 mAs. All patients underwent colonic preparation the day before the exam, consisting in a low residue diet and the intake of phosphate-based cathartics. Before image acquisition and if not contraindicated, patients received 2 ml of hyoscine butylbromide by intramuscular injection.

Colonic distention was obtained by manual insufflation of room air in 50 patients and by insufflation of CO\(_2\) with an automatic insufflation pump in 150 patients. In all patients, scans were acquired both in prone and supine positions. The total procedure time was calculated in each group and a Student’s t-test was used to calculate the differences.

At the end of the test, patients completed a questionnaire about the degree of discomfort perceived. We used a scale of 0 to 3: 0- no discomfort (no discomfort during the procedure), 1- mild discomfort (feeling of distention with mild pain at some time during the procedure), 2- moderate discomfort (feeling of distention with moderate pain over 50% of the procedure); 3- severe discomfort (severe pain during the entire procedure). A test of proportions was used to calculate the differences in the degree of discomfort between the two groups.

**RESULTS**

There were no complications in VC exams in either group. The total procedure time was 30.5 ± 7.5 minutes for studies performed using automatic insufflation with CO\(_2\) and 35.4 ± 9.9 minutes for those performed with manual room air insufflation. The difference was -4.9 min (p = 0.0003, 95% CI = -7.3 to -2.3).

As regards the assessment of discomfort, in the group insufflated with room air, 44% of patients reported a moderate degree of discomfort, while in the group insufflated with CO\(_2\), 76% of the patients expressed no discomfort. Table 1 shows results for both groups.

**DISCUSSION**

There are several diagnostic methods for CRC screening. VC has been recently incorporated as a screening method, with outcomes similar to those of optical colonoscopy (which is considered as the gold standard), but with the advantage of being a non-invasive method that requires no sedation, anesthesia or post-procedure recovery time.

In 2005, two meta-analyses reflected the performance of VC, including high-risk and screening patients. The analysis of 33 studies that provided data on 6393 patients showed a sensitivity ranging from 85% to 93% and a specificity of 97% for polyps larger than 10 mm; while the sensitivity for the diagnosis of invasive CRC was 96% \(^{2,3}\). In 2008, the American College of Radiology Imaging Network (ACRIN) released results of its multicenter trial, ACRIN 6664, which had enrolled more than 2500 patients at 15 institutions. This trial showed 90% sensitivity for the detection of patients with colorectal adenomas or cancer \(≥ 10\) mm in diameter.

Another main indication of VC is as a complement of an incomplete optical colonoscopy for assessment of the proximal colon. Without disregarding technical aspects, the main efforts are currently focused on improving patients’ perceptions of the procedure, by modifying bowel preparation, incorporating electronic cleansing techniques and making changes in colonic insufflation. As VC is performed without sedation, for this technique to be widely accepted, distention

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**Table 1:** Degree of discomfort in relation to the type of colonic insufflation.

<table>
<thead>
<tr>
<th>Type of insufflation</th>
<th>Degree of discomfort</th>
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<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Room air</td>
<td>10% (n=5)</td>
</tr>
<tr>
<td>CO(_2)</td>
<td>76% (n=115)</td>
</tr>
<tr>
<td>p Value</td>
<td>&lt; 0,001</td>
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should be achieved with an acceptable degree of discomfort for the patient. Based on a post-study questionnaire administered to 1005 patients (of a total of 1233 patients), Pickhardt et al \(^4\) documented that most patients experienced greater discomfort with VC (54.3\%) than with optical colonoscopy (38.1\%; \(p<0.001\)) and that 7.6\% of patients were undecided or indicated that both studies were equivalent with regard to comfort.

Colonic distention is, together with a good preparation, the most important prerequisite for a proper detection of polyps both in 2D and 3D imaging. From the beginning of VC, manual room air insufflation has been the most commonly used mechanism because of its availability, ease of use and low cost. However, its main disadvantage is the greater discomfort experienced by the patient during and after the procedure. Room air stays inside the colonic lumen for some hours, causing pain and abdominal distention of variable duration and degree.

Colonic insufflation with CO\(_2\) is an advantageous alternative for performing VC, as it causes significantly less patient discomfort during, and especially after the procedure. CO\(_2\) is readily absorbed through the colonic wall because of a steep diffusion gradient, and it is then exhaled from the lungs. In addition, the use of an insufflation pump ensures a progressive and controlled distention, avoiding spasms. The only disadvantage is the additional cost of equipment.

In our series of patients, the use of CO\(_2\) demonstrated better tolerance and less discomfort than the exam performed with room air. Sumanac et al \(^5\) found similar results in their study, where 100 patients were randomized to undergo VC with insufflation of room air and CO\(_2\). Post-procedural pain was assessed at 1 hour and 6 hours after colonoscopy: of patients insufflated with room air, 45\% and 31\% had pain at 1 hour and 6 hours, versus 7\% and 9\%, respectively for those insufflated with CO\(_2\). It is important to highlight that in our study pain was assessed during and immediately after VC, and not at 6 hours after completion of the procedure. Robson et al \(^6\) conducted another study in 142 patients who underwent barium enema: half of the patients were insufflated with room air and the other 50\% with CO\(_2\). An assessment of immediate and delayed discomfort showed that patients that had received CO\(_2\) experienced significantly less immediate and delayed pain than those that had received room air (12.5\% and 4.2\% versus 31\% and 12.9\%, respectively).

Shinners et al \(^5\) compared patient-controlled room air insufflation versus automated CO\(_2\) delivery. Although their data showed greater discomfort during active distention with CO\(_2\) compared with room air, this trend reversed after the examination (which can be attributed to the increased rate of CO\(_2\) resorption). Even if not statistically significant, differences in patient discomfort after the examination favored CO\(_2\).

CONCLUSIONS

Virtual colonoscopy performed with CO\(_2\) insufflation partially reduced the total procedure time, but, most importantly, significantly reduced discomfort during and after the examination. This resulted in better patient tolerance and acceptance of the procedure.

References