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A Comparative Study of Four Oral Contrast Agents for Small Bowel Distension With Computed Tomography Enterography

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Abstract

Purpose: To assess the efficacy of a variety of oral contrast agents in obtaining small bowel distention for computed tomography (CT) enterography examinations.

Methods: A retrospective study was developed to quantitatively assess small bowel luminal distension during CT enterography by using 4 contrast agents, which included water, Metamucil, polyethylene glycol, and lactulose. A total of 256 patients were enrolled in the study and included 64 individuals for each oral regimen. The widest loop of small bowel in each of 4 quadrants on representative coronal images was separately measured for luminal distension. Overall distension and the greatest number of ''useful'' quadrants were evaluated. Overall distension was calculated by summing the 4 quadrant values into an overall luminal diameter distention score (cm). A ''useful'' quadrant was defined as having a measurement of $\geq$2 cm. Each ''useful'' quadrant was assigned a score of 1, with values that ranged from 0-4.

Results: For overall distension, multivariable liner regression analysis showed that the lactulose group had a significantly higher overall distension value than Metamucil, polyethylene glycol, and water by 0.88, 0.92, and 1.63 cm, respectively, with 95% confidence interval. The categorical multivariable logistic regression analysis showed that the lactulose group had greater odds of having more ''useful'' quadrants than the Metamucil, polyethylene glycol, and water groups, with odds ratios of 3.51, 2.68, and 9.19, respectively.

Conclusion: Lactulose achieves better small bowel distension for CT enterography studies than the other 3 agents and, therefore, is the preferred oral regimen at our institution.

Résumé

Objectif : Évaluer l'efficacité de divers produits de contraste à induire une distension de l'intestin en vue d'une entérographie par tomodensitométrie (TDM).

Méthodes : Une étude rétrospective a permis d'évaluer quantitativement la distension intracavitaire de l'intestin grêle induite par quatre produits de contraste, notamment l'eau, le Metamucil, le polyéthylèneglycol et le lactulose dans le cadre d'une entérographie par TDM. L'étude a été menée auprès de 256 patients en tout, soit 64 patients par schéma posologique. La distension intracavitaire de l'anse grêle la plus large a été mesurée séparément dans chacun des quatre quadrants des images frontales représentatives. L'évaluation a porté sur la distension globale de l'intestin grêle et le nombre de quadrants « utiles » observé sur les images. La distension globale de l'intestin grêle a été calculée en additionnant les valeurs des quatre quadrants en vue d'obtenir un diamètre intracavitaire global exprimé en centimètres. Un quadrant était considéré comme étant « utile » s'il mesurait 2 cm et plus. Une note de 1 était ensuite attribuée à chaque quadrant « utile », les valeurs variant de 0 à 4.

Résultats : L'analyse de régression linéaire multiple a révélé qu'au chapitre de la distension globale, le groupe ayant reçu du lactulose affichait des variables nettement plus élevées que les groupes ayant reçu du Metamucil (écart de 0,88 cm), du polyéthylèneglycol (écart de 0,92 cm) et de l'eau (écart de 1,63 cm), selon un intervalle de confiance de 95 %. L'analyse de régression logistique à plusieurs variables

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nominales a pour sa part révélé que le groupe ayant reçu du lactulose était plus susceptible de présenter des quadrants « utiles » que les groupes ayant reçu du Metamucil (rapport de cote de 3,51), du polyéthylèneglycol (rapport de cote de 2,68) et de l'eau (rapport de cote de 9,19).

Conclusion : L'efficacité du lactulose à induire une distension de l'intestin grêle à des fins d'entérographie par TDM est supérieure à celle des trois autres produits, c'est pourquoi il constitue le schéma posologique de choix au sein de notre établissement.

Key Words: Computed tomography; Enterography; Oral contrast agents; Water; Metamucil; Polyethylene glycol; Lactulose; Small bowel distension

In recent years, small bowel imaging has benefited from technologic advances. Initially reliant upon small bowel follow-through and enteroclysis, small bowel pathology is more commonly diagnosed with multidetector row computed tomography (CT), magnetic resonance imaging, and various endoscopic methods. Multidetector row CT with high-volume neutral oral contrast agents is the cornerstone of CT enterography (CTE) [1]. CTE has become an accurate method of assessing small bowel pathology, with its main indications being inflammatory bowel disorders (particularly Crohn disease), obscure enteric bleeding, and intestinal neoplasms [2].

The success of CTE relies on the quality of luminal distention. Typically, neutral oral contrast agents, which have a density that is lower than the bowel wall and allows for improved conspicuity of mural and mucosal enhancement, are used. A variety of oral contrast agents have been studied. These include water, whole milk, polyethylene glycol (PEG), water with methylcellulose, lactulose, and 0.1% barium solution with sorbitol (VoLumen; Bracco, Milan, Italy) [3–9]. Megibow et al [3] reported VoLumen to be superior to a water-methylcellulose mixture; however, VoLumen is not currently available in Canada. To our knowledge, there has been no sizeable study that compared numerous neutral oral contrast agents in quantitative terms for CTE. The purpose of our study was to measure small bowel luminal distention with a variety of commonly used oral contrast agents. The agents studied included water, Metamucil (Procter and Gamble, Cincinnati, OH), PEG (GoLYTELY, Braintree Laboratories, MA), and lactulose. Our impression from previous experience has been that lactulose gives the best distention. We wanted to assess whether this was correct and to quantify the difference.

Materials and Methods

A retrospective study was developed for the quantitative assessment of small bowel distension during CTE by using 4 different oral contrast agents. The study was approved by the our institutional research and ethics board. Inclusion criteria consisted of any study labeled as ''CT enterography'' in our institutional PACS (picture and archive communication system) between 2006 and 2012. Exclusion criteria consisted of any study performed with the use of a nasojejunal tube (ie, CT enteroclysis), incomplete ingested dose, documented vomiting, omission of hyoscine butylbromide (Buscopan; Boehringer Ingelheim GmbH, Ingelheim, Germany) or imaging evidence of bowel obstruction. A total of 256 patients were enrolled in the study and included 64 individuals for each oral regimen (water, Metamucil, PEG, and lactulose). The first 64 studies performed with each oral contrast agent were selected after exclusions.

Oral Regimen

The 4 groups of neutral oral contrast agents studied were water, Metamucil, PEG (GoLYTELY, Braintree Laboratories, MA), and lactulose (Euro-LAC; Euro-Pharm, Montreal, Canada). Our institutional cost/patient was CAD$1.72 for Metamucil, CAD$1.44 for lactulose, and CAD$10.99 for PEG. Each cohort consisted of 64 patients. The patients in the water group drank 2 L over 60 minutes. The patients were scanned 20 minutes after ingestion of the last drink.

For Metamucil, a bulk-producing laxative and fiber supplement, 2 L were ingested over 80 minutes as 4 aliquots every 20 minutes. Each aliquot consisted of 2 packets (12 g/packet) in 500 mL of water. Patients were scanned 20 minutes after finishing the final dose. For PEG, an osmotic laxative, 2 L were consumed over 60 minutes. The patients were scanned 20 minutes after consumption of the final drink. For lactulose, a synthetic nondigestible sugar, 1.5 L were consumed over 60 minutes as 3 aliquots every 20 minutes. The patients were imaged immediately after the final drink. Each of the 3 drinks consisted of 40 mL (667 mg/mL) of lactulose diluted in 500 mL of water. Thus, only 1.5 L of lactulose had to be consumed, compared with 2 L of the other agents.

Image Acquisition

To achieve intestinal hypomotility, the patients received 1 mL (20 mg) of Buscopan intravenously while on the CT table just before imaging. All CTEs were performed on either a 64-row spiral CT scanner (Light Speed VCT; GE Healthcare, Milwaukee, WI) or a 16-row spiral CT scanner (Xtra Pro16; GE Healthcare) with contiguous axial acquisition and coronal and sagittal reformats. For VCT, the following protocol was applied: contrast injection: 120 mL of Omnipaque 350 (Iohexol; GE Healthcare) at