Comparison of neutral and positive enteral contrast media for MDCT enteroclysis

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Abstract

Objective: To compare neutral and positive enteral contrast media for MDCT enteroclysis (MDCTE) in various small bowel diseases.

Materials and methods: 40 patients with suspicion of small bowel diseases were divided randomly into two equal groups. In one group, water was used as neutral enteral contrast and in other group, 2% water soluble iodinated contrast was used as positive enteral contrast. All MDCTE were done on a 16-slice multidetector row CT unit. The findings of MDCTE were compared with the standards of reference.

Results: There were 12 cases of abdominal tuberculosis (30%), 5 cases of bowel masses (12%), 4 cases of Crohn’s disease (10%), 3 cases of small bowel adhesions (7%), 2 cases of midgut volvulus (5%), 2 cases of segmental enteritis (5%) and 12 of all cases (30%) were normal. There was no statistically significant difference between neutral and positive enteral contrast with regards to bowel distention, contrast reflux and evaluation of duodenum. Abnormal bowel wall enhancement was appreciated only with use of neutral enteral contrast (n = 12). Evaluation of ileocaecal junction was possible in all 20 patients (100%) with positive enteral contrast but in only 17 patients (85%) with neutral enteral contrast. Overall sensitivity and specificity of MDCTE with use of neutral contrast medium (100 and 88% respectively) was greater for evaluation of small bowel diseases, when compared to MDCTE using positive enteral contrast medium (92.8 and 83.3% respectively).

Conclusions: Water is a good enteral contrast medium for MDCT enteroclysis examination and allows better evaluation of abnormal bowel wall enhancement. Ileocaecal junction evaluation is better with positive enteral contrast medium.

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1. Introduction

Multidetector Computed Tomography Enteroclysis (MDCTE) is a novel method of examining the small intestine that combines the advantage of enteral volume challenge of enteroclysis and ability of cross-sectional imaging and reformatting of MDCT to depict the mural, extramural and extraintestinal manifestations of the dis-ease process [1–4]. MDCTE appears to be a promising technique for small bowel examination which could perhaps overcome the disadvantages of all the currently available techniques like barium meal follow through, barium enteroclysis and enteroscopy [5]. MDCTE can be performed with positive enteral contrast media like water soluble iodinated contrast or dilute barium solution (1–2%) and with neutral enteral contrast media like water, 0.5% methyl-cellulose or polyethylene glycol–electrolyte solution [2,6]. Positive enteral contrast has been reported to be useful in cases of intestinal obstruction and neutral enteral contrast in predicting the inflam-matory activity of Crohn’s disease [6]. However to the best of our knowledge, there is no prospective study comparing the two types of enteral contrast media in evaluation of small bowel. The aim of our study was to prospectively compare neutral with positive enteral contrast medium for MDCTE examination in various small bowel diseases.

2. Materials and methods

Study protocol was approved by the ethics committee of our institution. Written informed consent was taken from all patients enrolled in the study. CT enteroclysis was performed in 40 consecutive patients with clinical suspension of small bowel diseases. Study group included 29 males and 11 females (age range of 14–63 years, mean 42.5 ± 13 years). Clinical indications for MDCTE included abdominal pain (n = 28), low grade small bowel obstruction (n = 14), vomiting (n = 12), unexplained weight loss (n = 11), loss of appetite...
2.1. CT enteroclysis protocol

All patients fasted for at least 8 h before the procedure. Using local anesthesia (lignocaine 2% gel), a nasojejunal tube (Bilbao-Dotter hypotonic duodenography tube, 12F, Cook, Bloomington) was advanced past the duodeno-jejunal junction, under fluoroscopic guidance and the tip of the tube was positioned in the proximal jejunum. Total time taken for nasojejunal intubation under fluoroscopy was noted for every patient. No sedation was administered to patients during intubation. We did not encounter any failure of nasojejunal intubation. All 40 patients for MDCTE were randomly divided into two equal groups. In one group, 2% water soluble iodinated contrast was used as a positive enteral contrast. In the second group, neutral contrast i.e., water at room temperature was used as enteral contrast. All patients received 1.5 l of contrast over 12–15 min at the rate of 120–140 ml/min and were then shifted to the CT unit. No smooth muscle relaxant was used during the study. While on the CT table, infusion of another 500 ml of enteral contrast was started before CT acquisition and was continued during the period of scanning.

MDCTE was performed with a 16-slice multidetector row CT unit (Siemens Sensation 16, Siemens Medical System, Foresheim, Germany) by using the following scan parameters: 16 × 1.5 mm slice collimation, 0.5 s gantry rotation time, pitch of 1 and 10/10 mm section width with 2 mm reconstruction. 100 ml of non-ionic iodinated contrast (iohexol) was injected intravenously at the rate of 3 ml/s by using automated power injector and the delay between start of intravenous contrast administration and scanning was 70 s. CT acquisition was performed from domes of diaphragm to lower margin of symphysis pubis during a single breath-hold.

2.2. Image analysis

Post-processing of the acquired data was done on a work-station. Multiplanar reformatted sagittal, coronal and oblique coronal views were generated. Both the axial and reformatted views were analyzed by two radiologists who were blinded to the results of previous investigations, if any. Images were initially ana-lyzed for adequacy of small bowel distention, presence of small bowel obstruction, level of obstruction, degree of luminal dilatation, bowel wall thickening, abnormal bowel wall enhancement, mesenteric fat stranding, presence of strictures, adhesions or volvulus and mesenteric or retroperitoneal lymph node enlargement. Extraintestinal findings were also noted. Findings of MDCTE were correlated with standards of reference.

2.3. Standards of reference

The standards of reference were conventional endoscopy (n = 18), capsule endoscopy (n = 14), histopathological findings from surgical or endoscopic biopsy specimen (n = 12), cytological findings (n = 6) from image-guided fine needle aspiration cytology (FNAC), enteroscopy (n = 4) and clinical response to treat-ment (n = 3) in few abdominal tuberculosis cases in which no FNAC/biopsy was possible.

2.4. Statistical analysis

Comparison of neutral with positive enteral contrast media was done using Chi-square test. A statistical significant difference was accepted if P value was <0.05. Sensitivity, specificity, positive predictive valve, negative predictive value and accuracy with 95% confidence interval was calculated separately for studies done using positive and neutral contrast media.

3. Results

All 40 patients tolerated CT enteroclysis well. No adverse effects due to intravenous contrast medium injection were encountered in our study. Average fluoroscopic time for nasojejunal tube insertion was 5 min 17 s (±3 min 20 s).

The spectrum of small bowel diseases for MDCTE with neutral and positive enteral contrast is given in Table 1. Twelve patients did not show any small bowel abnormality on MDCTE (neutral enteral contrast, n = 6, positive enteral contrast, n = 6). The degree of small bowel distention using neutral contrast was good in 10 cases (50%) and adequate in 10 cases (50%) and by using positive contrast, good in 12 cases (60%), adequate in 7 cases (35%) and poor in 1 case (5%). However, there was no statistical difference between the degree of bowel distention achieved with use of neutral and positive enteral contrast medium (P value >0.05).

The incidence of contrast reflux by using neutral enteral con-trast was none in 3 cases (15%), mild in 6 cases (30%), moderate in 7 cases (35%), severe in 4 cases (20%) and by using positive contrast was none in 8 cases (40%), mild in 5 cases (25%), moderate in 2 cases (10%) and severe in 5 cases (25%). The incidence of contrast reflux was also not statistically significant by using neutral and positive contrast (P value >0.05). Adequate evaluation of duodenum was achieved in 6 cases (30%) using neutral enteral contrast and in 9 cases (45%) using positive enteral contrast. This was also not statistically significant. The ileocaecal junction was adequately evaluated in 17 cases (85%) by using neutral contrast and in all 20 cases (100%) by using positive contrast. This was statistically significant (P value <0.05).

Table 1

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Neutral enteral contrast</th>
<th>Positive enteral contrast</th>
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</thead>
<tbody>
<tr>
<td>Tuberculosis</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Crohn’s disease</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Bowel masses</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Segmental enteritis</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Adhesions</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Volvulus</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2
Comparison of diagnostic accuracy and predictive value between neutral and positive enteral contrast medium in MDCTE.

<table>
<thead>
<tr>
<th></th>
<th>Neutral enteral contrast</th>
<th>Positive enteral contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>True positive</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>True negative</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>False positive</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>False negative</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>100% (95% CI: 67.8–100%)</td>
<td>92.8% (95% CI: 64.1–96.6%)</td>
</tr>
<tr>
<td>Specificity</td>
<td>88% (95% CI: 50.6–99.4%)</td>
<td>83.3% (95% CI: 36.4–99.1%)</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>91% (95% CI: 59.7–99.5%)</td>
<td>92.8% (95% CI: 64.1–99.6%)</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>100% (95% CI: 59.7–100%)</td>
<td>83.33% (95% CI: 36.4–99.1%)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>95%</td>
<td>90%</td>
</tr>
</tbody>
</table>

The sensitivity, specificity and accuracy of neutral and positive enteral contrast for the diagnosis of small bowel diseases was 100%, 88%, 95% and 92.8%, 83.3%, 90% respectively (Table 2).

Out of 12 cases of abdominal tuberculosis, neutral enteral contrast was used in 8 cases (66%) and positive enteral contrast was used in 4 cases (34%). On MDCTE, one false positive and one false negative diagnosis for tuberculosis was made while using positive enteral contrast, while all 8 cases were diagnosed correctly as tuberculosis using neutral enteral contrast. Strictures with associated mural thickening were seen in 7 (58%) cases (Fig. 1A and B) and strictures alone were seen in 3 (25%) cases of abdominal tuberculosis. Associated mesenteric lymph node involvement was seen in 75% of cases. Abnormal bowel wall enhancement was seen only in 7 cases done with neutral enteral contrast (Fig. 2). Mucosal ulcerations were seen in 3 cases (neutral enteral contrast, n = 2, positive enteral contrast, n = 1), and mucosal fold thickening was seen in only one case (neutral enteral contrast, n = 1). Ileocaecal involvement was seen in 5 cases (neutral enteral contrast, n = 3, positive enteral contrast, n = 2). The overall sensitivity, specificity, positive predictive value, negative predictive value and accuracy of MDCTE in diagnosing all cases of abdominal tuberculosis were 92.3% (95% CI: 62–99.5%), 96.29% (95% CI: 79.1–99.8%), 92.3% (95% CI: 62–99.5%), 96.2% (95% CI: 79.1–99.8%), 95% respectively.

In our study, there were 5 cases of bowel masses which included one case each of jejunal carcinoid, primary ileal non-Hodgkin’s lymphoma, post transplant lymphoproliferative disorder involving ileum (Fig. 3), caecal adenocarcinoma and inflammatory appendicular mass. Only one patient with inflammatory appendicular mass was done using neutral enteral contrast and was wrongly diagnosed as gastrointestinal tumor of terminal ileum. Other four cases were done with use of positive enteral contrast, of which patient with caecal adenocarcinoma was misinterpreted as hypertrophic ileocaecal tuberculosis on MDCTE.

We encountered 4 cases of Crohn’s disease (2 cases each with neutral and positive enteral contrast) and two cases of segmental enteritis (one case each with neutral and positive enteral contrast). All of them were diagnosed correctly on MDCTE.

Of the 12 cases that presented with intestinal obstruction of different etiology, neutral enteral contrast was used in 5 cases and positive contrast was used in 7 cases. Two cases of low grade obstruction (positive enteral contrast, n = 1 and neutral enteral contrast, n = 1) were found to be normal on MDCTE and were confirmed by barium enteroclysis and barium meal follow through examination. Adhesions (25%) were the most common cause of intestinal obstruction in our study and all these patients had previous history of abdominal surgeries (Fig. 4). The sensitivity, specificity, positive predictive value, negative predictive value, accuracy of MDCT enteroclysis in predicting the level of low grade obstruction were 100% (95% CI: 56–100%), 96.9% (95% CI: 82.4–99.8%), 87.5% (95% CI: 46.6–99.3%), 100% (95% CI: 86.5–100%) and 97.5% and in predicting...
Fig. 3. 44-year-old male with post-transplant lymphoproliferative disorder. Coronal multiplanar reformatted MDCTE image of the patient done using positive enteral contrast showing the gross asymmetric mural thickening of the ileal loop with exophytic component (arrow). Transplant kidney is also seen.

the cause of low grade obstruction were 100% (95% CI: 51.6–100%), 94.1% (95% CI: 78.9–98.9%), 75% (95% CI: 35.5–95.5%), 100% (95% CI: 86.8–100%) and 95% respectively.

4. Discussion

Small bowel evaluation has always remained a diagnostic challenge for radiologists. After the advent of MDCT scanners, CT has been found to be more useful than barium studies as the method of investigation in evaluating small bowel diseases. Faster scan-ning, thinner collimation and multiplanar reformation are the main advantages of MDCT over routine CT [7–10]. The most common problem encountered during small bowel examination with CT is inadequate small bowel distention. This can be overcome by direct infusion of contrast medium into small bowel through nasojejunal intubation and then taking contiguous thin slices with MDCT.

MDCT enteroclysis is a novel technique which combines the advantage of enteroclysis and MDCT [11]. In this study, we tried to compare efficacy of neutral and positive enteral contrast in MDCT enteroclysis for evaluating small bowel diseases and found no statistically significant difference between the two enteral contrast media with respect to bowel distention, severity of contrast reflux and duodenal evaluation. But the ileocaecal junction evaluation was significantly better with positive contrast when compared to neutral contrast.

In cases of abdominal tuberculosis, we found neutral enteral contrast to be better than positive enteral contrast as the abnormal bowel wall enhancement (n = 7) was appreciated only when neutral enteral contrast was used. Mucosal ulcerations and fold thickening were also better seen when neutral enteral contrast was used. Hence, signs of disease activity in tuberculosis like abnormal mural enhancement and mucosal abnormalities were better detected with use of neutral enteral contrast. To the best of our knowledge, there are no studies in English literature which have evaluated the role of CT enteroclysis in abdominal tuberculosis.

All four cases of Crohn’s disease done with using positive and neutral enteral contrast showed presence of ileal strictures and were correctly diagnosed on MDCTE. Abnormal bowel wall enhancement associated with inflammatory activity of Crohn’s disease was also appreciated in two of the cases done with neutral enteral contrast.

The sensitivity and specificity of CT enteroclysis with positive enteral contrast has been reported to be 89 and 100% in cases of low grade intestinal obstruction [12,13]. In our study, the overall sensitivity and specificity of MDCT enteroclysis in predicting the level of low grade obstruction were 100 and 96.9% respectively and for the cause of low grade obstruction were 100 and 94.1% respectively. Twelve cases (30%) with clinical suspicion of small bowel diseases showed no abnormality on MDCTE and were confirmed by other investigations like BMFT, barium enteroclysis, enteroscopy, capsule endoscopy and MIBG scan. These cases were considered as true normal. Of all 12 true normal cases, 4 cases had shown false positive mural thickening on routine CT abdomen with positive enteral contrast. This was due to under distention of small bowel in conventional CT abdomen. This finding is similar to that reported in a study by Maglinte [14].

Extraintestinal findings were noted in 25 cases (62%). Among these cases, relevant extraintestinal findings which contributed to diagnosis of basic disease were seen in 9 cases (22%). This was one of the major advantages of MDCT enteroclysis when compared to conventional enteroclysis. Mesenteric lymphadenopathy (27%) was the commonest extraintestinal manifestation.

In our study, the sensitivity, specificity and accuracy of water as enteral contrast media was 100%, 88% and 95% respectively, when compared to positive enteral contrast which was 92.8%, 83.3% and 90% respectively. However in view of the small sample size and the non-homogeneous disease spectrum, no statistical significance can be attached to these results. The advantages of water as enteral contrast media are accurate estimation of bowel wall thickness, mucosal enhancement, bowel wall edema, mucosal fold thick-enings and ulcerations. The inflammatory activity of the diseases like tuberculosis and Crohn’s disease was very well brought out when neutral enteral contrast medium used. In our study abnormal bowel wall enhancement was seen in 12 cases, mucosal ulcer-

Fig. 4. 28-year-old male with recurrent abdominal pain for 2 months who had previous history of abdominal surgery. Sagittal multiplanar reformatted MDCTE image done using neutral enteral contrast showing small bowel adhesion to anterior pari-etal wall (arrow).
tions in 2 cases and mucosal fold thickening in 1 case, when neutral enteral contrast was used. Water is also cheaper and readily available. Few drawbacks of using water as enteral contrast medium were also encountered in our study. These were increased incidence of contrast reflux (25% more compared to positive enteral contrast), inadequate evaluation of ileo-caecal junction (15% less when compared to positive enteral contrast). With respect to bowel distention, good distention was attained in 60% of cases using positive contrast compared to 50% when water was used as neutral enteral contrast. However, only the difference in evaluation of ileo-caecal junction between neutral and positive enteral contrast was statistically significant. The limitations of this study included limited number of cases and the multiple standards of reference that were used to confirm the diagnosis. Although there is no universal agreement regarding the ideal contrast medium in the literature, we found neutral contrast to be a better enteral contrast medium for MDCT enteroclysis examination especially in cases of abdominal tuberculosis. Its overall sensitivity, specificity and accuracy were better compared to positive enteral contrast, although positive enteral contrast evaluated the ileocaecal junction better.

References


