Use of IV-contrast versus IV-and oral-contrast in the evaluation of abdominal pain on CT in the emergency department

Poster No.: B-0693
Congress: ECR 2016
Type: Scientific Paper
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Keywords: Emergency, Abdomen, Contrast agents, CT, PACS, Contrast agent-intravenous, Contrast agent-oral
DOI: 10.1594/ecr2016/B-0693

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Purpose

Abdominal pain is one of the most common presenting complaints of patients in the Emergency Department (ED), accounting for roughly 5% of ED visits.¹ The differential diagnosis for abdominal pain is extensive and the consequences of abdominal pain range from acute life-threatening emergencies to minor discomfort. Often times, history and physical exam findings in the ED are not enough to distinguish between the life-threatening causes and minor causes of abdominal pain, which leads to several diagnostic challenges. It is essential to accurately assess the severity of a patient's abdominal pain in a timely fashion to avoid missing an acute, severe situation. However, it is also important to minimize extra tests and potential harm to patients who have pain or discomfort that will ultimately dissipate naturally within a few hours or days. Computed tomography of the abdomen and pelvis (CTAP) is one of the most useful and commonly used imaging modalities to evaluate abdominal pain as it clearly depicts the anatomy of the abdomen and pelvis, and can accurately ascertain several acute, severe causes of abdominal pain.

Intravenous (IV) and/or oral (PO) contrast agents are often administered for enhanced evaluation of the patient's abdominal and pelvic structures. In 2008, our urban academic teaching hospital adopted a policy limiting the use of oral contrast in ED patients presenting with non-traumatic abdominal pain. Before our hospital's protocol change, all patients presenting to the ED with non-traumatic abdominal pain who necessitated a CTAP scan received both oral- and IV-contrast, unless contraindicated due to medical renal disease or contrast allergy. After the change in protocol, this same patient population received IV-contrast only CTAP scans. The purpose of this study was to investigate the potential impacts of limiting the use of oral contrast in patients presenting to the ED with non-traumatic abdominal pain.
Methods and materials

This Health Insurance Portability and Accountability Act (HIPAA)-compliant, retrospective study performed at our urban academic teaching hospital was approved by the institutional review board (IRB). Informed consent was waived. A database of patients, aged 18 and older, receiving CTAP for non-traumatic abdominal pain from our hospital's ED was assembled using electronic medical records, with pre- and post-policy implementation cohorts selected from two randomly chosen months, August 2008 and August 2012. 221 consecutive patients presenting to the ED with non-traumatic abdominal pain during the month of August 2008 who received oral- and IV-contrast enhanced CTAP were included in the study. Similarly, 248 consecutive patients presenting to the ED with non-traumatic abdominal pain during the month of August 2012 who received IV-contrast only enhanced CTAP were included in the study.

Patients who did not receive oral and/or IV contrast when undergoing CTAP for non-traumatic abdominal pain in August 2008 were excluded from the study. Similarly, patients who received oral contrast, or did not receive IV contrast, when undergoing CTAP for non-traumatic abdominal pain in August 2012 were excluded from the study.

Parameters assessed in this study included ED length of stay (LOS), time to CT scan from ED triage, time to first radiology read, time to disposition from the ED after the first radiology read, and radiation dose. Mann Whitney U-tests were used in data analysis.
Results

In August 2008, 221 patients received oral- and IV-contrast enhanced CTAP for non-traumatic abdominal pain. 248 patients from August 2012 received IV-contrast only enhanced CTAP for non-traumatic abdominal pain. Baseline characteristics for both groups are shown in Table 1. In addition, Table 1 lists certain diagnoses of particular clinical importance, including acute appendicitis, acute cholecystitis, acute colitis, acute diverticulitis, acute pancreatitis, ileus or small bowel obstruction, and incarcerated hernia. Figure 1 demonstrates findings from a patient with acute appendicitis who underwent oral-and IV-contrast enhanced CTAP. Conversely, Figure 2 demonstrates findings from a patient with acute appendicitis who underwent IV-contrast only enhanced CTAP. The most common diagnosis in each study group was unspecified abdominal pain. There were several other less common diagnoses that were not specifically listed in Table 1. Of note, the frequencies of the listed diagnoses were not different between the study groups. When correlated with clinical findings and pathology results, there were no acute, severe abdominal diagnoses that were missed on radiological read in either study group.

As Table 2 demonstrates, ED LOS was significantly shorter for patients in the IV-contrast only group. The median ED length of stay from ED triage to disposition was 6:13 hours (373 minutes) with IV-contrast only enhanced CT scans compared to 7:35 hours (455 minutes) with oral- and IV-contrast enhanced CT scans (p < 0.0001).

Time to CT from ED triage was also significantly shorter for patients in the IV-contrast only group. The median time from ED triage to the CT exam was 3:11 hours (191 minutes) with IV-contrast only enhanced CT scans compared to 4:57 hours (297 minutes) with oral- and IV-contrast enhanced CT scans (p < 0.0001).

Time to first read was significantly shorter for patients in the IV-contrast only group. The median time from the CT scan to the resident/attending read was 43 minutes with IV-contrast only enhanced CT scans compared to 65 minutes with oral- and IV-contrast enhanced CT scans (p < 0.0001).

Time to disposition after the first CT exam read was significantly longer for patients in the IV-contrast only group compared to the oral- and IV-contrast group. The median time after the CT exam was performed and read to the time when the patient left the ED was 1:39 hours (99 minutes) after IV-contrast only enhanced CT scans compared to 1:14 hours (74 minutes) after oral- and IV-contrast enhanced CT scans (p < 0.01).

Radiation dose was significantly less in the IV-contrast only group. The median radiation dose reported for IV-contrast only enhanced CT scans was 13.35 mGy (CT dose index,
CTDvol) and 671.15 mGy-cm (dose length product, DLP) compared to 23.30 mGy (CTDvol) and 1170.50 mGy-cm (DLP) for oral- and IV-contrast enhanced CT scans (p < 0.0001).
Fig. 1: Axial (A) and coronal (B) images from an oral- and IV-contrast enhanced CTAP that demonstrate diffuse mucosal enhancement of the appendix with surrounding fluid and fat stranding (arrow). The appendix measures up to 7 millimeters in diameter. These findings are consistent with acute appendicitis.

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Fig. 2: Axial (A) and coronal (B) images from an IV-contrast enhanced CTAP that demonstrate dilatation and mucosal enhancement of the appendix with surrounding fat stranding (arrow). The appendix measures up to 10 millimeters in diameter. These findings are consistent with acute appendicitis. Incidental note is made of a horseshoe kidney.

Table 2: Oral- and IV-contrast enhanced Abdominal and Pelvic CT vs IV-contrast only enhanced Abdominal and Pelvic CT

<table>
<thead>
<tr>
<th></th>
<th>Oral- and IV-contrast enhanced CTAP Median (IQR)</th>
<th>IV-contrast only enhanced CTAP Median (IQR)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total ED LOS</td>
<td>n = 221 7:35 (6:21-9:11)</td>
<td>n = 248 6:13 (4:43-7:47)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time to CT scanner from ED triage</td>
<td>221 4:57 (4:02-6:28)</td>
<td>248 3:11 (2:14-4:29)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time to First Read</td>
<td>221 1:05 (0:46-1:37)</td>
<td>246 0:43 (0:30-1:06)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Time to Disposition from First Read</td>
<td>186 1:14 (0:45-2:25)</td>
<td>238 1:39 (0:58-2:39)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>CTDIvol (mGy)</td>
<td>116 23.30 (16-27)</td>
<td>246 13.35 (8-19)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>DLP (mGy·cm)</td>
<td>116 1170.50 (789-1441)</td>
<td>246 671.15 (431-963)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Table 2: CT - Computed Tomography, ED - Emergency Department, IQR - Interquartile Range, CTDIvol - CT Dose Index, DLP - Dose Length Product

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Conclusion

When comparing CTAP studies with IV-contrast only enhancement to CTAP studies with oral- and IV-contrast enhancement, there is a median decrease in ED LOS of about 1:22 hours (82 minutes). This difference is likely accounted for by the amount of time required to prepare a patient for a CTAP with oral-contrast enhancement. This process involves the consumption of a water-soluble contrast solution with the main purpose of distending and coating the bowel appropriately.

Similarly, time to the CT scanner from the ED triage area was about 1:46 hours (106 minutes) shorter for patients who underwent IV-contrast only enhanced CT studies. This, too, was most likely related to the necessary time it takes to prepare a patient for an oral-contrast enhanced study.

Time to first read by an attending or resident radiologist was approximately 22 minutes shorter for IV-contrast only enhanced CT studies compared to oral- and IV-contrast enhanced CT studies. This might demonstrate that IV-contrast only enhanced CTAP studies are easier or quicker to read than oral- and IV-contrast enhanced CTAP studies. However, this more likely relates to schedule differences at our hospital between 2008 and 2012.

Although time to first read was shorter for the IV-contrast only enhanced CT group, ED disposition time after the first read was roughly 25 minutes longer for the IV-contrast only enhanced CT group compared to the oral- and IV-contrast enhanced CT group. This suggests ED disposition relies on several more factors than the CTAP study alone.

Regarding radiation dose measurements, the median CT dose index (CTDIvol) and dose length product (DLP) for patients who underwent IV-contrast only enhanced CTAP was 57% the magnitude of the CTDIvol and DLP for patients who underwent oral- and IV-contrast enhanced CTAP. This difference is likely related to protocol differences at our hospital between 2008 and 2012.

Compared to other medical centers, limiting the use of oral-contrast in patients with non-traumatic abdominal pain appears to have similarly positive effects on the efficiency of diagnosis and ED LOS. In a study performed at the University of Utah School of Medicine, ED LOS was roughly 2 hours shorter using an IV-contrast only protocol compared to an oral- and IV-contrast protocol for ED patients undergoing CTAP. ²
In a study performed at Brigham and Women's Hospital, median time to CTAP decreased by 27 minutes and median ED LOS decreased by 30 minutes for an IV-contrast only protocol versus an oral- and IV-contrast protocol.\textsuperscript{3}

Similarly, in a study comprising over 6,000 patients performed at two university-affiliated, urban hospitals, ED LOS was reduced by 43 minutes using an IV-contrast only protocol compared to an oral- and IV-contrast protocol for ED patients undergoing CTAP.\textsuperscript{4}

This study did not investigate indications for re-scanning patients with non-traumatic abdominal pain who did not receive oral-contrast enhancement on initial CTAP. Of note, a previously performed study demonstrated that lack of oral-contrast enhancement does not compromise the clinical efficacy of a CT scan.\textsuperscript{5}

In conclusion, limiting the use of oral-contrast for CTAP in patients with non-traumatic abdominal pain in the ED has positive effects on the efficiency of diagnosis and ED LOS.
Personal information

The authors declare no conflict of interest.
References


