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Abdominal Imaging / Imagerie abdominale

# Intravenous and Oral Contrast vs Intravenous Contrast Alone Computed Tomography for the Visualization of Appendix and Diagnosis of Appendicitis in Adult Emergency Department Patients

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## Abstract

**Purpose:** The study sought to compare radiologist's ability to 1) visualize the appendix; 2) diagnose acute appendicitis; and 3) diagnose alternative pathologies responsible for acute abdominal pain among adult patients undergoing computed tomography (CT) scan with 3 different protocols: 1) intravenous (IV) contrast only; 2) IV and oral contrast with 1-hour transit time; and 3) IV and oral contrast with 3-hour transit time.

**Methods:** We collected data of 225 patients; 75 consecutive patients with a clinical suspicion of appendicitis received oral contrast for 3 hours and IV contrast, 75 received oral contrast for 1 hour and IV contrast, and 75 trauma patients received IV contrast only. Three independent reviewers, blinded to final pathology, retrospectively analysed the cases and documented visualization of the appendix, peri-appendiceal structures, and their confidence in diagnosing appendicitis. Clinical diagnoses were derived from a combination of clinical, surgical, pathologic, or radiologic follow-up.

**Results:** Frequency of visualizing the appendix within IV group alone was 87.3%, IV with oral for 1 hour was 94.1%, and IV with oral for 3 hours was 93.8%. Both oral contrast groups had 100% sensitivity and negative predictive value in diagnosis of acute appendicitis. Specificity for the 1- and 3-hour oral contrast groups was 94.1% and 96.1%, respectively and positive predictive value for both groups was 92%.

**Conclusions:** Our findings suggest that reader confidence in visualizing the appendix improved with addition of oral contrast as compared to IV contrast alone. One- and 3-hour oral regimens have a similar diagnostic performance in diagnosing appendicitis.

## Résumé

**Objet :** Cette étude vise à comparer la capacité du radiologiste 1) à visualiser l'appendice, 2) à diagnostiquer une appendicite aiguë et 3) à diagnostiquer les autres causes possibles de la douleur abdominale aiguë chez les patients adultes, dans le cadre d'une tomographie par ordinateur (TDM) réalisée selon 3 protocoles, c'est-à-dire 1) avec administration par voie intraveineuse (IV) d'un produit de contraste, 2) avec administration par voie orale et voie intraveineuse d'un produit de contraste avec temps de transit de 1 heure et 3) avec administration par voie orale et par voie intraveineuse d'un produit de contraste avec temps de transit de 3 heures.

**Méthodes :** Nous avons recueilli des données sur 225 patients, soit 75 patients consécutifs susceptibles de présenter une appendicite et ayant reçu un produit de contraste par voie orale (3 heures) et par voie intraveineuse, 75 patients ayant reçu un produit de contraste par voie orale (1 heure) et par voie intraveineuse et 75 patients victimes de traumatismes ayant reçu un produit de contraste uniquement par voie intraveineuse. De façon rétrospective, trois examinateurs indépendants ont interprété les cas à l'insu de la pathologie finale et documenté la visualisation de l'appendice et des structures péri-appendiculaires, ainsi que leur niveau d'assurance pour le diagnostic d'appendicite. Les diagnostics cliniques ont été posés à partir d'une combinaison de suivis cliniques, chirurgicaux, pathologiques ou radiologiques.

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**Résultats :** La fréquence de visualisation de l'appendice chez les patients ayant uniquement reçu un produit de contraste par voie intraveineuse s'est chiffrée à 87,3 %, contre 94,1 % chez les patients ayant reçu un produit de contraste par voie orale (1 heure) et voie intraveineuse, et 93,8 % chez les patients ayant reçu un produit de contraste par voie orale (3 heures) et voie intraveineuse. Les deux groupes ayant reçu un produit de contraste par voie orale ont présenté une sensibilité et une valeur prédictive négative de 100 % pour le diagnostic d'appendicite aiguë. La spécificité s'est chiffrée à 94,1 % pour le groupe ayant reçu un produit de contraste oral avec temps de transit de 1 heure, et à 96,1 % pour celui ayant reçu un produit avec temps de transit de 3 heures. Dans les deux cas, la valeur prédictive positive s'est élevée à 92 %.

**Conclusions :** L'étude révèle qu'en ce qui concerne la visualisation de l'appendice, le niveau d'assurance de l'examineur est plus élevé s'il y a ajout d'un produit de contraste par voie orale. Les protocoles intégrant un temps de transit de 1 heure et de 3 heures affichent toutefois une efficacité diagnostique semblable pour le diagnostic d'appendicite.

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*Key Words:* Appendicitis; Appendix; Computed tomography; Oral contrast

Acute appendicitis is one of the common causes of acute abdominal pain and the most common acute condition of the abdomen requiring surgery, with a lifetime incidence rate of 1 in 400 [1,2]. Acute appendicitis has been classified as a medical emergency because delayed diagnosis is associated with an increased mortality and morbidity due to an increased risk of septic shock, peritonitis, and injury to intra-abdominal organs [3,4].

The clinical assessment of a patient presenting with abdominal pain includes patient history, physical examination and laboratory tests. At the Foothills Medical Centre (Calgary, Canada), the Alvarado scoring system is used for determining the probability of acute appendicitis as a cause of the abdominal pain. The scoring is based on a scale of 1-9; a composite of 6 clinical findings and 2 laboratory measurements [5]. In case of an Alvarado score between 4-7, the probability of acute appendicitis is intermediate and our protocol is to perform a computed tomography (CT) or ultrasonography (US) to either rule in acute appendicitis or, if present, establish an alternative diagnosis. Although clinicians use CT or US for evaluating abdominal pain, CT is a more accurate test, with a 95% sensitivity and 95%-100% specificity in diagnosing acute appendicitis [6]. CT has been shown to reduce the false-negative appendectomy rate without increasing the rate of appendiceal perforation [7]. The most widely used CT protocol for imaging the abdomen in diagnosing acute appendicitis is administering both positive oral and intravenous (IV) contrast media and scanning with a standard radiation dose CT technique [8]. Although widely used, oral contrast administration has several drawbacks. Studies have shown that despite allowing 1-2 hours between contrast intake and scanning, oral contrast material fails to reach the cecum in 18%-30% of the patients and therefore may not aid in the diagnosis of appendicitis [9,10]. The 1-2-hour time period also prolongs patient-stay in emergency departments (ED) and results in delayed diagnosis [11]. Whether prolonged ED stays contribute to increased risk of appendiceal perforation continues to be controversial. Although delayed operative intervention increases the risk of rupture [12], an association between perforation and increased in-hospital time prior to surgery

among adults treated with appendectomy is yet to be established [13]. Moreover, patients with abdominal pain often present with nausea and vomiting. Therefore, drinking oral contrast not only increases patient discomfort, but also increases the risk of aspiration pneumonia [14].

Although the protocol entailing a combination of oral and IV contrast material has high sensitivity and specificity for diagnosing acute appendicitis, multiple variations of contrast administration such as IV [15], oral [16], or rectal [4] contrast material alone, triple contrast (IV, oral, and rectal) [17], or completely unenhanced have been described in literature as well [18]. Anderson et al [19] found similar sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) in patients randomized to undergo IV contrast enhanced CT with or without oral contrast material for the diagnosis of appendicitis. However, in this study, the interpretations of individual readers showed a nonstatistically significant trend in favor of oral contrast administration [19].

The lack of consensus and formal recommendation by American College of Radiology and Canadian Association of Radiology on the optimal contrast technique for diagnosing acute appendicitis has led to a wide variation in clinical practice depending on institutional and individual preference.

### Goal of This Study

The purpose of this study was to compare the radiologist's ability to visualize the appendix and diagnose acute appendicitis among 3 groups of patients undergoing abdominal CT: IV contrast only (IV) vs IV and oral contrast (IVO) with 1-hour transit time (IVO<sub>1</sub>) vs IVO with 3-hour transit time (IVO<sub>3</sub>).

### Methods

#### *Study Design and Selection of Participants*

Adult patients presenting to the ED with abdominal pain assigned an Alvarado score between 4-7, and undergoing CT scans were included in this retrospective single-centre study.

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