Radiographic contrast media: A new risk for pulmonary aspiration ?

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Aspiration of high osmolar water soluble radiographic contrast media (RCM) is dangerous and can induce severe bronchial irritation and pulmonary edema. Low osmolar RCM are well tolerated by the lungs following aspiration with minimal histological reaction (1).

A 43-year-old man with dysphagia and a tendency to aspirate was found to have squamous cell carcinoma of the esophagus. Curative surgery was planned and preoperative computed tomography of the chest and abdomen was ordered. A ward nurse administered Gastrografin (Diatrizoate Meglumine and Diatrizoate Sodium Solution) according to a "standing" order, 4 hours before the CT was to be done. The patient aspirated about 50 mL of Gastrografin, and went into cardiorespiratory arrest caused by pulmonary edema. He sustained severe brain damage and died (2)

Omnipaque (iohexol) and 3% Gastrografin (meglumine diatrizoate) are used as contrast media for esophagography and computed tomography respectively. Twenty-four rats were injected intratracheally with 0.15 mL of one of three contrast agents (omnipaque, full-strength Gastrografin and 3% Gastrografin) or normal saline, which was used as a control. Radiographs were then obtained. Equal numbers from each experimental group were sacrificed after 5 minutes, 1 hour and 24 hours, and their lungs were examined pathologically. The rats injected with full-strength Gastrografin all died immediately of gross pulmonary edema. Neither Omnipaque nor 3%

Gastrografin was fatal, but Omnipaque produced more edema and alveolar hemorrhage than either normal saline or 3% Gastrografin. Iohexol is, therefore, more irritating to the airways and the lung parenchyma than previously believed (3).

Experimental aspiration of water soluble contrast agents was performed on rats via transoral endotracheal injection. Iopamidol, iohexol and diatrizoate were the contrast agents tested. One group of rats received normal saline as a control. Adjusted lung weights were measured at 2 and 24 hours post aspiration. Radiographs were taken at 2 and 24 hours post aspiration and scored for abnormal pulmonary air space density. Diatrizoate alone demonstrated an increase in adjusted lung weights. Diatrizoate, iopamidol and iohexol showed abnormal pulmonary air space disease on radiographs at 2 hours but not at 24 hours. Histopathologic examination of rat lungs following aspiration of all three contrasts showed pulmonary vascular congestion and perivascular edema. Iopamidol showed evidence of acute cellular inflammation. Iohexol provoked a pulmonary alveolar macrophage response (4).

Lung tissue reaction to endobronchial application of iopamidol and ioxithalamate were compared by chest radiograph and histological examination in the rat. Radiographs cleared within hours in both groups. Tissue reaction after ioxithalamate application was significantly more pronounced than with iopamidol and included macrophage response, partial atelectasis, and intra-alveolar and interstitial oedema (5).

Moore et al. (6) studied the short- and long-term radiographic, physiologic and histologic changes elicited in the lung of rabbits following the aspiration of commonly used radiographic contrast agents. All agents used, including nonionic agents, caused radiographically evident pulmonary edema which cleared by 24 hours. The contrast materials with higher osmolality, viscosity, and iodine content elicited the greatest physiologic and pathologic changes. No differences were found between an ionic and a nonionic agent with similar viscosities and iodine content, despite a lower osmolality in the nonionic agent. No contrast agent was innocuous when introduced into the lung.

Aspiration is a serious complication of oral contrast media (CM). Miyazawa et al. (7) investigated the effects of iotrolan, iopamidol, and diatrizoate in rats' lungs. To quantify the lung damage induced by CM, pulmonary water and hemoglobin contents were determined. Arterial blood-gas exchange (pH, PCO2, and PO2) also was determined as an indicator of respiratory function. Iotrolan, iopamidol, or sodium/meglumine diatrizoate with a concentration of 300 mg I/mL was administered intrabronchially at a dose of 1 mL/kg. Physiologic saline was administered to the control group. Ten minutes after administration, arterial blood was collected and the lung was removed. Diatrizoate and iopamidol increased pulmonary water and hemoglobin contents and decreased blood PO2. The effect of iotrolan on these parameters was slight and no significant differences were observed between the iotrolan and saline groups. These results suggest that iotrolan is a preferable CM for gastrointestinal examination in the case of suspected aspiration.

The water soluble contrast agents Gastrografin (Sodium diatrizoate and meglumine diatrizoate, Schering, Berlin), Iopamiro 300 (Iopamidol, Schering, Berlin), and Dionosil Aqueous (propyliodone BP, Glaxo, England) were instilled into the tracheobronchial tree of rats in doses of either 0.1 ml and 0.25 ml. Rats being used as controls, underwent sham operations with the instillation of air instead of contrast agent. In all, 85 rats were used. All rats that had not already died from the effects of contrast agent were sacrificed 30 minutes after instillation. The relative effects of the contrast agents were measured by comparing: 1. survival time; 2. radiographic effects of the contrast agents on the lungs and; 3. pathological changes as estimated by post mortem lung section and microscopy. The least toxic agent was the one with the lowest osmotic activity, namely Aqueous Dionosil. It is therefore recommended that Aqueous Dionosil be used in preference to Gastrografin or Iopamidol for studies of the oesophagus whenever there is a danger of aspiration of contrast agent into the tracheobronchial tree (8).

Ganguli et al (9) retrospectively determined the value of the nonvisualized appendix at multidetector computed tomography (CT) in patients with acute right lower quadrant pain in whom appendicitis was a consideration. Records were retrospectively reviewed in patients who presented to the emergency department between April 29 and October 31, 2003, with right lower quadrant pain. Scanning was performed with the same eight-detector row CT scanner by using oral and (unless contraindicated) intravenous contrast agents, and transverse and coronal reformations were obtained. Two radiologists prospectively evaluated all scans at the time of the examination and rendered a consensus opinion. Clinical follow-up of at least 3 months' duration was

performed retrospectively for patients whose appendix was not visualized to determine whether appendicitis had developed. Statistical analysis and calculation of percentages with confidence intervals (CIs) were performed. Of the 400 consecutive patients who underwent multidetector CT, 132 (33.0%) were male and 268 (67.0%) were female. Eighty patients (20.0%) had acute appendicitis and 79 (19.8%) had another cause for abdominal pain. A normal appendix with no other cause for pain was seen in 182 patients (45.5%). In 59 patients (14.8%), the appendix was not visualized. Of these 59 patients, 50 had adequate follow-up. Clinical follow-up was uneventful in 49 of these 50 patients. Thus, on otherwise normal multidetector CT scans in patients suspected of having acute appendicitis, nonvisualization of the appendix was negative for appendicitis in 98% (95% CI: 71%, 100%) of cases. Conversely, when the appendix was seen at multidetector CT and was abnormal, appendicitis was present in 95% (95% CI: 72%, 100%) of cases. In patients with right lower quadrant pain, a nonvisualized appendix at multidetector CT reliably excludes acute appendicitis.

Acute appendicitis is the most common acute abdominal condition that results in surgical intervention in childhood. The clinical diagnosis of acute appendicitis in children can be challenging. Approximately one-third of children with the condition have atypical clinical findings and are initially managed nonoperatively. Complications associated with delayed diagnosis of this condition include perforation, abscess formation, peritonitis, sepsis, bowel obstruction, infertility, and death. The use of cross sectional imaging has proven useful for the evaluation of suspected acute appendicitis in children. Both graded compression sonography and CT have been widely utilized in the

imaging assessment of the condition. The principal advantages of sonography are its lower cost, lack of ionizing radiation, and ability to assess ovarian pathology that can often mimic acute appendicitis in female patients. The principal advantages of CT include less operator dependency than sonography as reflected by a higher diagnostic accuracy, and enhanced delineation of disease extent in perforated appendicitis (10).

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Appendicitis is the most common condition requiring intraabdominal surgery in infancy and childhood. Yet, despite its common occurrence, accurate diagnosis remains challenging. Acute appendicitis may be missed at initial clinical examination in 28%-57% of children aged 12 years and younger and in nearly 100% of children under the age of 2 years. Diagnostic imaging has an ever-increasing role in the prompt and accurate diagnosis of acute appendicitis in the pediatric population. Helical CT with rectally administered contrast material has been shown to reduce the total number of inpatient observation days, laparotomies with negative findings, and per-patient cost. Helical CT is a highly sensitive and specific tool for diagnosing pediatric appendicitis and has resulted in a beneficial change in patient care in 68.5% of all patients seen in emergency department for suspected appendicitis. This includes both those patients who receive an eventual diagnosis of appendicitis and those who do not have the disease. Major strengths of limited helical CT with rectal contrast material include producing uniformly high published sensitivity and specificity values for diagnosis of appendicitis and enabling diagnosis of alternative conditions of acute abdominal pain in children. In contrast, limitations of graded-compression ultrasonography in

children include highly operator-dependent sensitivity and specificity values and relative infrequency with which the normal appendix can be visualized in this population. Although there have been many exciting diagnostic advancements for the diagnosis of acute appendicitis in the pediatric population, the role of helical CT is far from clear (11).

Pediatric fasting guidelines are intended to reduce the risk of pulmonary aspiration of gastric contents and facilitate the safe and efficient conduct of anesthesia. Recent changes in these guidelines, while assuring appropriate levels of patient safety, have been directed at improving the overall perioperative experience for infants, children, and their parents. Now after nearly 15 years of practice worldwide, the relative safety and benefits of allowing clear liquids up to 2 hr prior to anesthesia for otherwise healthy children are well established. Shortened fasting periods for breast milk (3 hr), formula (4 hr) and light meals (6 hr) are supported by accumulated experience and an evolving literature that includes evidence of minimal gastric fluid volumes (GFVs) at the time of surgery. Ideal fasting intervals for children with disorders that may affect gastrointestinal transit have yet to be determined (12).

The ASA formed a Task Force in 1996 to review relevant clinical human research studies published 1966 to 1996. Over 1100 citations were initially identified, of which 232 articles contained relationships between preoperative fasting and pharmacological prophylaxis of pulmonary aspiration. Expert opinion was also obtained from international anesthesia and gastroenterologist consultants in preparing clinical guidelines for preoperative

fasting and pharmacological prophylaxis in healthy patients undergoing elective surgery. These were approved by the House of Delegates at the 1998 ASA Annual Meeting and were published in the March 1999 issue of Anesthesiology (13).The Canadian Anesthesio-logists' Society has published similar guidelines (14).

However, there are no guidelines regarding the use of ingestion of radiographic contrast media at the preoperative period. Is it 2 hours like clear fluids? 4 hours like breast milk ? or 6 hours like infant formula or non-human milk?

Coursey et al. (15) examined the frequency of preoperative computed tomography (CT) in the evaluation of patients suspected of having appendicitis at one institution during the past 10 years to determine whether changes in CT utilization were associated with changes in the negative appendectomy rate.

A surgical database search yielded medical record numbers of 925 patients (526 [56.9%] men and 399 [43.1%] women; mean age, 38 years (range, 18–95 years]) who underwent urgent appendectomy between January 1998 and September 2007. Patients who were younger than 18 years of age at the time of surgery were excluded. CT, pathology, and surgery reports were reviewed. By using logistic regression, changes in the proportion of patients undergoing CT and in the proportion of patients undergoing each year appendectomy in which the appendix was healthy were evaluated. Subgroup analyses based on patient age (≤ 45 years or > 45 years) and sex also were performed.

Prior to urgent appendectomy, 18.5% of patients underwent preoperative CT in 1998 compared with 93.2% of patients in 2007. The negative appendectomy rate for women 45 years of age and younger decreased from 42.9% in 1998 to 7.1% in 2007. However, the timing of the decline in negative appendectomy rates for women 45 years and younger could not be proved to be associated with the increase in CT use. There was no significant trend toward a lower negative appendectomy rate for men regardless of age or for women older than 45 years of age with increased use of preoperative CT. The shift from single-detector CT to multidetector CT and the use of decreasing section thickness also correlated with a reduction in false-positive diagnoses.

Rising utilization of preoperative CT and advances in technology coincided with a decrease in the negative appendectomy rate for women 45 years and younger but not in men of any age or women older than 45 years.

The risk of RCM pulmonary aspiration during tracheal intubation in less than 6 hours from the RCM ingestion should be also a crucial risk factor regarding the proper timing of surgery of these patients.

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