Clinical Radiology 69 (2014) 1264–1272

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.clinicalradiologyonline.net

Incidence of contrast medium extravasation for CT and MRI in a large academic medical centre: A report on 502,391 injections

K. Shaqdan, S. Aran, J. Thrall, H. Abujudeh*

Department of Radiology, Massachusetts General Hospital, Harvard Medical School, USA

ARTICLE INFORMATION

Article history:
Received 30 May 2014
Received in revised form
28 July 2014
Accepted 6 August 2014

AIM: To present the authors' experience of contrast medium extravasation (CME) during both CT and MRI examinations in a large academic medical centre.

MATERIALS AND METHODS: The present retrospective investigation was conducted between June 2008 and June 2013. The radiology data and medical records of patients in whom CME had occurred were reviewed.

RESULTS: The extravasation rate for CT and MRI was 0.11% (541/502 391); the % was 0.13% during CT and 0.06% during MRI. There was a statistically significant difference between females and males in the overall % ($p = 0.0062$), and the number of extravasations between CT and MRI ($p < 0.0001$). At MRI, the incidence of CME in patients >60 years was statistically significant when compared to the 18–60 year age group ($p = 0.0072$). Of 90 MRI patients with extravasation, CME occurred in 51 (0.048%, 51/105,578) patients from manual injections, and 39 (0.087%, 39/44,688) patients from automated injection with statistical significance ($p = 0.0048$). A statistical significance was found between females receiving automatic injections and males receiving manual injections ($p = 0.0161$). The majority of CME during CT and MRI occurred in the outpatient department [64.5% (291/451) and 64.4% (58/90), respectively], but the overall incidence of CME was highest in inpatients [0.29%, (160/54,664) in CT and 0.16% (32/20,048) in MRI].

CONCLUSION: Patients undergoing CT are at higher risk of developing CME than MRI patients. Females and inpatients were also were more likely to develop CME at both CT and MRI. At MRI CME is more likely in patients above the age of 60 years and for those receiving automated power injections.

Introduction

Intravenous contrast agents are commonly used for both CT and MRI to aid in the detection, characterization, and staging of disease.[1] Approximately 76 million CT examinations are performed annually in 8465 hospital and non-hospital sites in the USA.[2] For MRI, an estimated 33.8 million procedures were performed in approximately 7800 hospital and non-hospital sites in the USA.[3]

Contrast medium extravasation (CME) is not an infrequent event, and is a well-recognized complication.[4] Although extravasation injuries are usually minor and resolve spontaneously, some cases result in serious

* Guarantor and correspondent: H. Abujudeh, Department of Radiology, Massachusetts General Hospital, Harvard Medical School, USA.
E-mail addresses: Habujudeh@partners.org, abujudeh.hani@mgh.harvard.edu (H. Abujudeh).

http://dx.doi.org/10.1016/j.crad.2014.08.004
0009-9260/

complications,[5] which can lead to longer hospital stays and increased morbidity and costs,[6] with surgical procedures needed to treat some complications.[7,8] For CT, the literature reported extravasation rates in the range of 0.14–0.9% and an average of 0.43%.[9–14] For MRI, gadolinium-based contrast agents (GBCAs) are associated with less adverse events.[15,16] MRI CME events are generally less common than CT because of the low volume of contrast medium given and the higher frequency of manual injections. According to the American College of Radiology (ACR) manual published in 2013, "The frequency of all acute adverse events after an injection of 0.1 or 0.2 mmol/kg of gadolinium chelate ranges from 0.07% to 2.4%[17]". The vast majority of these reactions are mild, including symptoms of warmth or pain at the injection site, paraesthesias, itching, nausea with or without vomiting, and dizziness.[17] However, there was no specific mention pertaining exclusively to the rate of CME.

Review of the literature reveals that certain risk factors increase the possibility of a patient developing CME. A large number of studies regarding CME rates after CT have been reported; however, there are no studies published regarding CME after MRI to the authors' knowledge or comparing CME at CT versus at MRI within the same institution. The aim of the present study was to describe CME events at CT and at MRI based on 502,391 injections. To the authors' knowledge, this is the largest study in the literature.

Background

With the advancements of CT technology (multiphasic organ imaging and quicker delivery of intravenous contrast media), faster injection rates allow optimal organ enhancement at CT, effectively increasing the chance of detecting disease.[13,18] However, automated power injection may increase the incidence of CME as it can allow extravasation of large volumes in a short period of time.[18] The Infusion Nurses Society (INS) defines an extravasation as the "inadvertent" administration of a vesicant solution into surrounding tissue, instead of into the intended vascular pathway.[5] A vesicant is an agent that has the potential to cause blistering or tissue necrosis such as radiological contrast media.[6]

The clinical presentation of CME ranges from minor swelling and redness to tissue death associated with progressive oedema and skin ulceration.[18] Most extravasation injuries heal spontaneously in 2–4 days, but extravasation might cause severe complications, such as acute compartmental syndromes, which may require emergency fasciotomy to prevent neurovascular compromise.[18]

The risk factors associated with CME can be caused by a number of mechanical, physiological, or pharmacological causes. Mechanical factors, such as choice of injection site, can increase the risk of developing extravasation.[19–22] For example, injection sites in the lower limb and small distal veins are more likely to result in extravasation, and are less ideal than the antecubital fossa.[17] Pharmacological factors, such as administration of high osmolar and a larger volume of contrast medium, are also associated with a higher risk of CME.[17] Certain human factors can also put the patient at a higher risk of CME. Patients who are unable to communicate adequately such as small children, the elderly, and mentally disabled are also at high risk of CME, partially because they may not or may be unable to complain of pain at the injection site.[4] The 2013 ACR manual on contrast media states that patients with altered circulation, such as arterial insufficiency (diabetics, PVD), fragile or damaged veins (side-effect of chemotherapy), and insufficient venous drainage, have increased risk of extravasation and are less able to tolerate the complications.[18]

Detecting extravasations and follow-up methods

To determine the occurrence of extravasation, one technologist is present next to the patient as they receive the injection, and another technologist is in the control room monitoring the volume of contrast media injected. The technologists are never exposed to radiation. They leave the room prior to start of the CT examination. This can happen in the middle of the injection or after the entire injection has been administered depending on the protocol. If the patient complains of pain or other symptoms, regardless of the volume, the injection is always stopped immediately. When the patient complains of pain or any other symptom at a level of $\geq$10 ml, this is regarded as extravasation that should be reported as per protocol. The technologist determines the amount of contrast medium that was injected and extravasated. The technologist then immediately contacts the radiologist/radiology nurse to examine the extravasation site after having removed the needle and to elevate the patient's affected extremity when possible. The radiologist/nurse assesses the site for swelling, change of sensation, altered tissue perfusion, and skin ulceration or blistering. The radiologist ultimately determines whether the plastic surgery service should be consulted.

Immediately after establishing that an extravasation event has occurred, the radiologist contacts the referring physician regardless of whether the patient is an inpatient or outpatient. At the same time, the technologist will also notify the inpatient's nurse. Further complications to the patient are recorded in the safety reporting system. In the case of an outpatient, a nurse or radiology manager will follow-up with the outpatient within 24 h. If the patient does not respond or does not call back, a last effort email is sent to the referring physician. A response to the email is documented into the safety reporting system. The patient is also instructed to report to the emergency department immediately if the overlying skin changes colour, swelling increases, or the patient continues to experience any untoward symptoms. Continued skin site care is also explained in detail to the patient or caretaker.

Methods and materials

This study was conducted at a large academic medical institution. A retrospective analysis was performed of the radiological data and medical records of patients in whom