Journal of Cardiovascular Computed Tomography xxx (2017) 1–5

Contents lists available at ScienceDirect

Journal of Cardiovascular Computed Tomography

journal homepage: www.JournalofCardiovascularCT.com

Technical report

The use of intraosseous needles for injection of contrast media for computed tomographic angiography of the thoracic aorta

Michael Winkler, MD [a, b, *], Cynthia Talley, MD [c], Connor Woodward [a], Alexander Kingsbury [a], Frank Appiah [a], Hossam Elbelasi, MD [a, b], Kevin Landwher [a], Xingzhe Li [a], Dominik Fleischmann, MD [d]

[a] Department of Radiology, University of Kentucky, Lexington, KY, USA
[b] Division of Cardiovascular Medicine, Department of Internal Medicine, University of Kentucky, Lexington, KY, USA
[c] Department of Surgery, University of Kentucky, Lexington, KY, USA
[d] Department of Radiology, Stanford University, Stanford, CA, USA

ARTICLE INFO

Article history:
Received 7 October 2016
Received in revised form
8 March 2017
Accepted 12 March 2017
Available online xxx

Keywords:
Intraosseous needle
Computed tomography
Angiography
Thoracic aorta
Traumatic aortic injury
Emergency radiology
Injection
Contrast media

ABSTRACT

Background: The objective of this study is to evaluate the safety and quality of computed tomographic angiography of the thoracic aorta (CTA-TA) exams performed using intraosseous needle intravenous access (ION-IVA) for contrast media injection (CMI).

Methods: All CTA-TA exams at the study institution performed between 1/1/2013 and 8/14/2015 were reviewed retrospectively to identify those exams which had been performed using ION-IVA (ION-exams). ION-exams were then analyzed to determine aortic attenuation and contrast-to-noise ratio (CNR). Linear regression was used to determine how injection rate and other variables affected image quality for ION-exams. Patient electronic medical records were reviewed to identify any adverse events related to CTA-TA or ION-IVA.

Results: 17 (~0.2%) of 7401 exams were ION-exams. ION-exam CMI rates varied between 2.5 and 4 ml/s. Mean attenuation was 312 HU (SD 88 HU) and mean CNR was 25 (SD 9.9). A strong positive linear association between attenuation and injection rate was found. No immediate or delayed complications related to the ION-exams, or intraosseous needle use in general, occurred.

Conclusion: For CTA-TA, ION-IVA appears to be a safe and effective route for CMI at rates up to 4 ml/s.

1. Introduction

The majority of victims of major trauma require computed tomographic angiography of the thoracic aorta (CTA-TA) as part of their imaging evaluation.[1] CTA-TA requires intravenous access (IVA) for contrast media injection (CMI) at high flow rates.[2] Peripheral IVA is favored for this purpose, but is not always achievable.[2] In such circumstances, central lines can be used for CMI.[2] In instances when central line placement is inexpedient or impossible, an alternative exists: intraosseous needle intravenous access (ION-IVA) (see Figs 1 and 2). ION-IVA placement is safer and faster than central line placement, with a failure rate of less than 1%.[3]

A recent clinical review by Baadh et al. calls for imaging physicians to familiarize themselves with the technique of using ION-IVA for CMI.[4] There is a substantial body of mid twentieth century literature, predating the advent of computed tomography, reporting the safe use of ION-IVA for CMI during fluoroscopic venography studies.[5] Fairly recent data on the safe use of ION-IVA for CMI from animal models has also been published.[6,7] However, modern literature reporting the clinical use of ION-IVA for CTA-TA is sparse.[4,8–10] The objective of this study was to retrospectively survey the safety of ION-IVA CMI performed during CTA-TA and to assess the quality of the resultant exams.

Abbreviations: CTA-TA, computed tomographic angiography of the thoracic aorta; IVA, intravenous access; CMI, contrast media injection; *P*-IVA, peripheral intravenous access; ION-IVA, intraosseous needle intravenous access; ION-exams, examinations performed using ION-IVA; CNR, contrast-to-noise ratio.

* Corresponding author. University of Kentucky, 800 Rose Street, Room HX-313A, Lexington, KY, 40536-0293, USA.
E-mail address: michael.winkler@uky.edu (M. Winkler).

http://dx.doi.org/10.1016/j.jcct.2017.03.001
1934-5925/

2. Materials and methods

7401 CTA-TA exams, performed between January 1, 2013 and August 14, 2015, were reviewed to create a CTA-TA database. Written informed consent was waived by the Institutional Review Board due to the retrospective nature of the project and because of the large number of exams included in the database. CTA-TA quality measurements were performed from survey series of 3.0 mm thick images. Attenuation and noise were measured within the ascending aorta and nearby adipose tissue using circular region-of-interests of approximately 100 mm.[2] Contrast-to-noise ratio (CNR) for the aorta was derived using the method of Feuchtner et al.[11] Other CTA-TA data collected included technical factors such as site of IVA, CMI rate, CMI dose, scanner type, and reconstruction method. Patient data, such as age, sex, weight, height, and chest width, was collected. The institutional adverse event reporting system was queried for all events related to CTA-TA. Complete chart review was performed for all patients who received CTA-TA exams utilizing ION-IVA.

Statistical analyses were performed using open source "R" statistical software version 3.1.1. Scatterplots and correlation coefficients were used to examine adequacy of a linear association between CNR and covariates of interest. The potential of multicollinearity was assessed with the Pearson correlation coefficient. Multiple linear regression models were fitted with two-way interactions. Backward elimination procedure, F-statistic, and adjusted R squared were used to select parsimonious models. Constant variance, normality, and independence were examined.

3. Results

17 (~0.2%) of 7401 of the exams performed during the study period utilized ION-IVA. All ION-exams were performed with EZ-IO needles (Teleflex Medical, Limerick, Pennsylvania, U.S.A.). CMI rates for ION-exams varied between 2.5 and 4.0 ml/s (mean of 3.4 ml/s). CMI dose varied between 80 and 100 ml (mean of 91 ml) of Iohexol 350. Mean attenuation for the ION-exams was 312 HU (SD 88 HU) and mean CNR was 25 (SD 9.9). Assessment of attenuation versus other covariates revealed a strong positive linear association between attenuation and CMI rate ($R = 0.58$, p-value $= 0.014$) and a strong negative association between attenuation and chest width ($R = -0.53$, p-value $= 0.028$). CNR also exhibited a strong negative linear association with chest width ($R = -0.77$, p-value<0.001). ION-exam and patient data is summarized in Table 1. Representative images from exemplary ION-exams are presented in Fig. 2 (and GIFs 1 and 2 online).

No extravasation events related to CMI via ION-IVA occurred. However, it is interesting to note that two patients received ION-

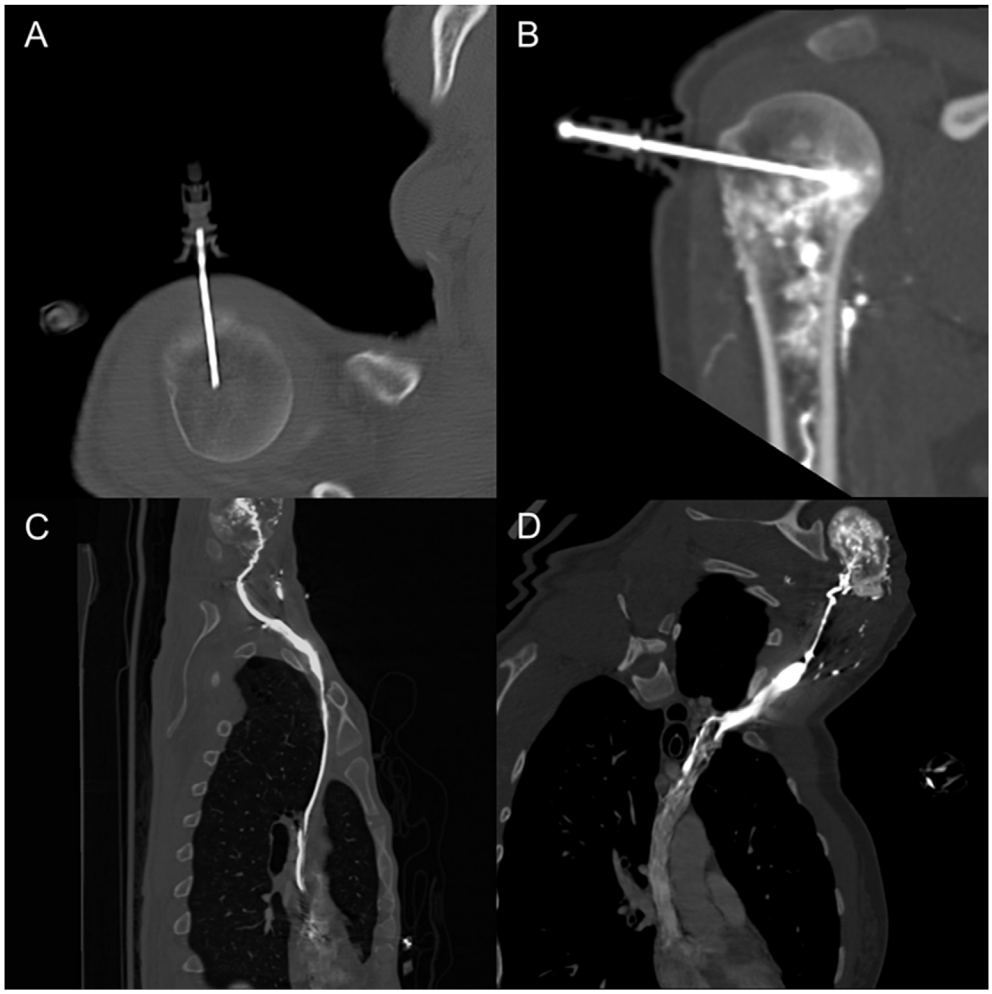

Fig. 1. A) MPR image derived from a preliminary scan performed to check intraosseous needle position. B) Thin MIP image derived from a scan showing an intraosseous needle and contrast media within the intramedullary space. C) CPR image showing path of contrast media from right humerus to the right atrium. D) Path of contrast from the left humerus.

Please cite this article in press as: Winkler M, et al., The use of intraosseous needles for injection of contrast media for computed tomographic angiography of the thoracic aorta, Journal of Cardiovascular Computed Tomography (2017), http://dx.doi.org/10.1016/j.jcct.2017.03.001