Ultra low-dose catheter directed CT angiography (CCTA) for the assessment of vascular suitability prior to endovascular aneurysm repair (EVAR) and ischemic lower extremity vasculature

Poster No.: C-1596
Congress: ECR 2014
Type: Scientific Exhibit
Authors: D. M. Santos, A. Formosa, A. Common, D. Marcuzzi, V. Prabhudesai; Toronto, ON/CA
Keywords: Interventional vascular, Arteries / Aorta, Contrast agents, CT-Angiography, CT, Technical aspects, Aneurysms
DOI: 10.1594/ecr2014/C-1596

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Aims and objectives

Intravascular contrast agents are one of the most common causes of acute kidney injury (AKI) in hospitalized patients [1] and one of the strongest predictors of this complication is contrast volume [2]. Therefore, decreasing contrast load may lead to decreased incidence of contrast-induced nephropathy (CIN). Exposure to large volume of contrast media required for evaluation of vessels in computed tomography angiography (CTA) may lead to CIN in high-risk patients (diabetes mellitus, cardiovascular disease, peripheral vascular disease, pre-existing renal dysfunction and history of renal surgery). Catheter directed CT angiography (CCTA) is a recently described technique that allows a drastic reduction of contrast material dose via direct delivery of dilute intra-arterial contrast media [3].

We retrospectively analyzed a cohort of patients who underwent CCTA to minimize contrast volume exposure. CCTA was performed for pre-operative assessment prior to endovascular aneurysm repair (EVAR) and assessment of pelvic and lower extremity vessels in patients with peripheral vascular disease. Since the likelihood of aortic aneurysms and peripheral vascular disease increases with age, a majority of this population consisted of elderly patients. The purpose of this study was to assess the feasibility of using ultra-low dose CCTA in the preoperative evaluation of abdominal aortic aneurysms and lower limb circulation.
Methods and materials

Approval from the research ethics board was obtained prior to the study. Retrospective analysis of patients who underwent CCTA at our centre between March 2011 and May 2013 was performed. Data acquisition was obtained using a 64-slice VCT scanner (2005) for both procedures.

Imaging Technique

Informed consent was obtained from all patients prior to the invasive procedure. As customary in our institution, a transfemoral arterial catheter was placed in the Interventional Radiology suite (IR suite). The catheter tip was positioned appropriately in the distal abdominal aorta. The catheter was secured and connected to continuous saline irrigation. The patient was then transferred to the CT room for scanning.

RUNOFF

Dilute contrast was prepared using 50mL of undiluted contrast in 200mL of injectable saline. This was injected via a power injector at a rate of 7mL/s. Scouts were obtained as usual to delineate area and localize catheter tip position for scan planning prior to injection.

Two timing boluses were employed. With the first timing bolus (Timing Bolus A), 20mL of diluted contrast was injected and images at the level of the popliteal arteries were obtained to determine the length of time from injection to maximum intensity of contrast at the knees. A second timing bolus of 20mL was used and imaged at ankles. The volume of dilute contrast injected was dependent on the total scan time. The area scanned was from level above the catheter tip down to the bottom of the feet.

The scan exposure time was determined accordingly: (1) Exposure Time(s) > Timing Bolus A x 2; (2) Exposure Time(s) > Timing Bolus B(s). To ensure that the acquisition did not outrun the contrast, both statements (1 and 2) needed to be valid. This was achieved by either adjusting the scan rotation speed, the pitch or both; ensuring that acquisition time matched peak contrast opacification for both proximal and distal arteries. An upfront scan delay of 3.4 seconds was used to provide breathing instructions and the scan exposure time was adjusted to finish 3 seconds after the timing bolus to ensure appropriate contrast through distal arteries.

PRE-EVAR
For aortoiliac assessment prior to EVAR, a total volume of approximately 100mL of dilute contrast was prepared by mixing 10ml of iodinated contrast with 90mL of injectable saline. This was injected via a power injector at a rate of 10mL/s.

Scouts were used to localize the catheter tip location prior to injection. A timing bolus using 20mL of diluted contrast was injected and images at the level of the symphysis pubis were obtained to determine the length of time from injection to the maximum intensity of contrast at that level. (Figure 1)

The final scan area was from above the catheter tip to below the femoral bifurcation. There was an upfront scan delay of 3.4 seconds to provide breathing instructions. The scan exposure time was adjusted to finish 3 seconds after the timing bolus to ensure there was appropriate contrast through the femoral arteries. CT acquisition was obtained helically at a slice thickness of 0.625mm, 120 kV and the mA was modulated depending on patient size.

**Image Analysis**

Data was reconstructed at 1.25 mm axial slices, 5.0 mm coronal and sagittal slices and sent to PACS. The original images were also sent to the work station for manipulation.

For image analysis, multiplanar reformations were generated using an advanced image processing software with 3D visualization capabilities. Scans were analyzed independently by two vascular radiologists for quality and vascular abnormalities.
Images for this section:

Fig. 1: Scans depicting the timing bolus with the region of interest centered at femoral arteries, with timing plotted onto a corresponding graph.

© Medical Imaging, St. Michael's Hospital - Toronto/CA
Results

CCTA IN RUNOFF PATIENTS

Twenty four patients aged between 64 to 87 (mean 75±6) years were scanned using the above protocol. Eight patients (33.3%) were female, and sixteen (66.7%) were male.

Contrast volumes ranged from 12.5 to 33.5mL, with a mean of 28mL (SD±5.1). Both observers determined all 24 scans (100%) to be diagnostic (Figure 2) to assess the vessels above the knee joints. Figures 3 and 4 depict examples of optimal quality images rendered, with Figure 3 obtained from the pelvis and Figure 4 from the pelvis through to the ankles. In 5 cases (20.8%), both observers deemed scans suboptimal in quality below the knees, citing proximal occlusion in 3 cases, stenosis in 1 case, and calcification in 1 case as causes for poor opacification.

CCTA IN PRE-EVAR PATIENTS

Eleven patients for pre-EVAR assessment aged 69 to 89 (mean 78±6) years were scanned using the above protocol. Five patients (41.7%) were female, and seven (58.3%) were male.

The cumulative volume of test boluses and CCTA contrast used ranged from 7mL to 28mL, with a mean of 11mL (SD±7.7). Both observers agreed that scans were diagnostic in all 11 patients (100%).
Images for this section:

**Fig. 2:** (A) CCTA images depicting excellent visualization of the vessels from the pelvis, knees, down to the ankles. (B) Contrast runoff as straight-line MPR.

© Medical Imaging, St. Michael's Hospital - Toronto/CA
Fig. 3: 3D volumetric images showing the distal aorta, iliacs and femoral arteries.

© Medical Imaging, St. Michael's Hospital - Toronto/CA
**Fig. 4:** 3D volumetric image showing vascular detail to trifurcation.

© Medical Imaging, St. Michael's Hospital - Toronto/CA
Fig. 5: Shaded surface display (SSD) of an abdominal aortic aneurysm (AAA) imaged for EVAR planning.

© Medical Imaging, St. Michael's Hospital - Toronto/CA
Conclusion

Methods by which to reduce the incidence of CIN continue to be explored. Decreasing incidence of CIN lies with identifying high-risk patients (based on age, creatinine clearance and presence of diabetes), ensure adequate hydration by intravenous saline [4], withdrawal of nephrotoxic drugs, as well as the administration of the lowest possible amount of contrast [5].

This retrospective study adapted the low-dose CCTA procedure first described by Joshi et al. [3] to assess aortic aneurysms prior to EVAR and peripheral vascular disease in runoff cases. We demonstrated that this intra-arterial approach is suitable for assessment of abdominal aortic aneurysms (n=11) and lower extremity vasculature (n=24).

The ultra-low volume of contrast utilized in CCTA is a key factor in the prevention of CIN, especially in the elderly population considered for EVAR and runoff, given that advanced age poses as an independent risk factor for CIN [4].

This intra-arterial catheter approach permitted the use of an average of 11mL of contrast for aortic aneurysm analysis, as compared to the 100-120mL used in previous reports [6, 7]. For runoff, an average of 28mL was employed, compared to the 150-180mL used in the standard CTA protocol at our site. In both sub-groups such a drastic dose reduction nonetheless maintained good diagnostic ability. Our study confirmed the success of CCTA with ultra-low dose contrast in assessing abdominal aortic aneurysms and lower extremity peripheral vascular disease-demonstrating that this preventative measure for CIN did not preclude adequate image quality.

One of the limitations of our study was its retrospective nature. Given this limitation, this study did not confirm whether the low volumes of contrast employed caused CIN. Future studies would benefit from addressing the incidence of CIN using this technique.

In conclusion, the adoption of CCTA in pre-EVAR and runoff procedure planning allows minimal exposure to contrast medium for patients predisposed to CIN without sacrificing diagnostic quality.
References


