REDUCTION OF RADIATION AND INTRAVENOUS CONTRAST DOSES IN TRIPHASIC CONTRAST CT ABDOMINAL AORTOGRAM

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Background

- Triphasic contrast computed tomography (CT) abdominal aortogram is currently the modality of choice for imaging surveillance of patients after endovascular aneurysm repair (EVAR).

- Published recommendations of interval scans at 1, 6 and 12 months post-operation and at yearly interval thereafter.

- The ***prolonged nature*** of surveillance scans with ***triphasic protocols*** impose ***substantial radiation exposure*** and ***considerable contrast dose*** to the patients.

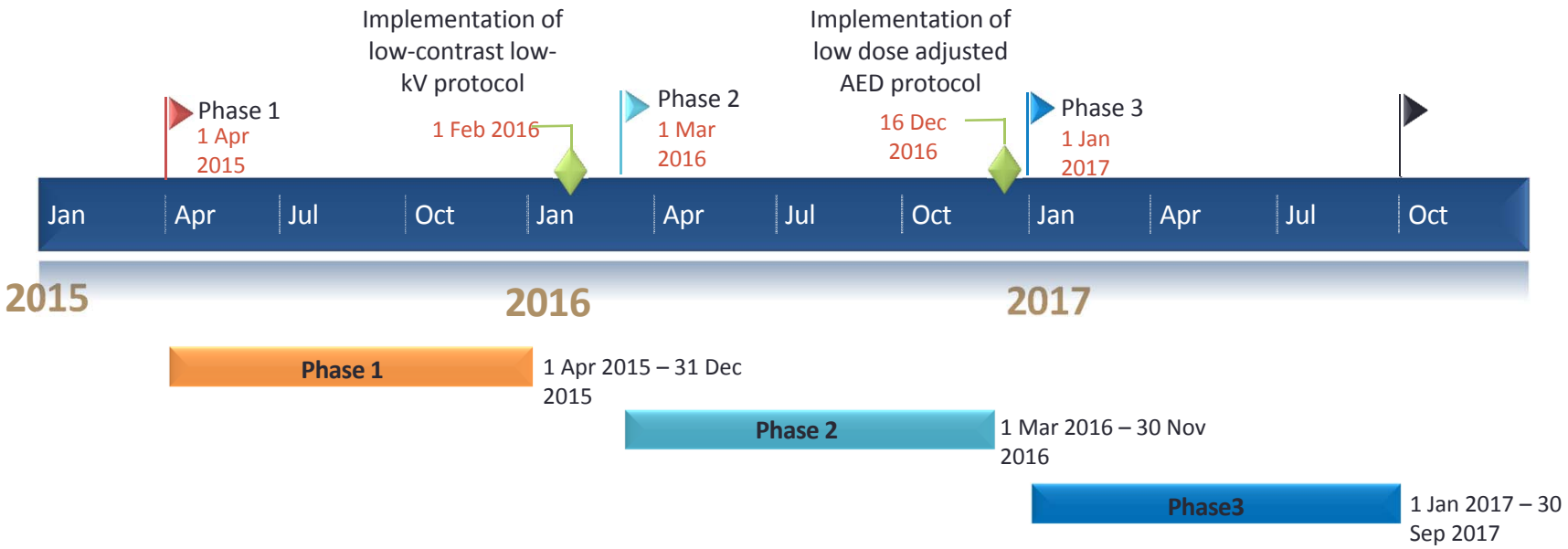
Background

- In order to reduce the radiation dose to patient in CT, the tube voltage could be decrease.
- The volume of iodine contrast can be reduced as greater attenuation of iodine at low tube voltage.
- Post EVAR patients usually have multiple risk factors (e.g. DM, HT) for renal impairment or contrast induced nephropathy.

Background

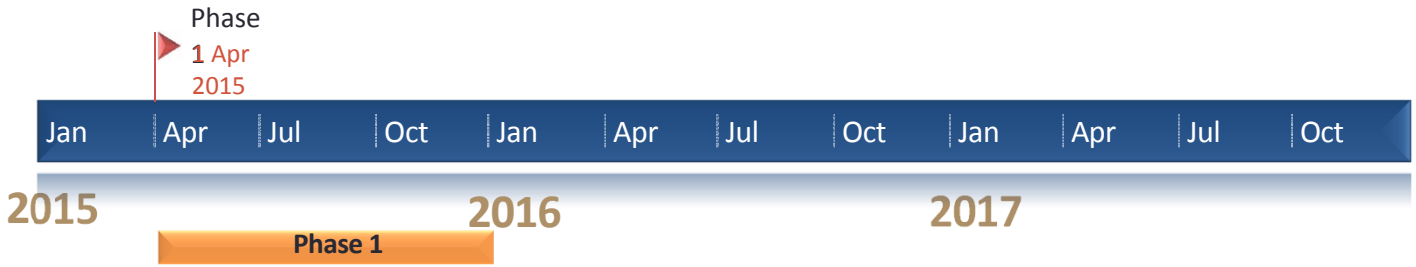
- Combination of low-contrast low-kV imaging technique in contrast CT aortogram.
- Low-voltage technique CT would increase image noise.
- Audit review on the radiation and contrast doses reduction of CT abdominal aortogram and image quality.

A three-phase audit



Phase 1

- To evaluate the radiation doses of the triphasic contrast CT abdominal aortograms performed at my department.
- 1st April 2015 – 31st December 2015 inclusive (9-month period)
- 55 patients (49 male, 6 female)



Phase 1

- Scanning Protocol
  - Intravenous contrast dose: **80ml Omnipaque 350mg/ml** → 30ml saline flush
  - Tube voltage: **120kV**

- Data Collection and Analysis
  - **Patient demographics**
  - **Radiation dose**

Phase 1 - Result

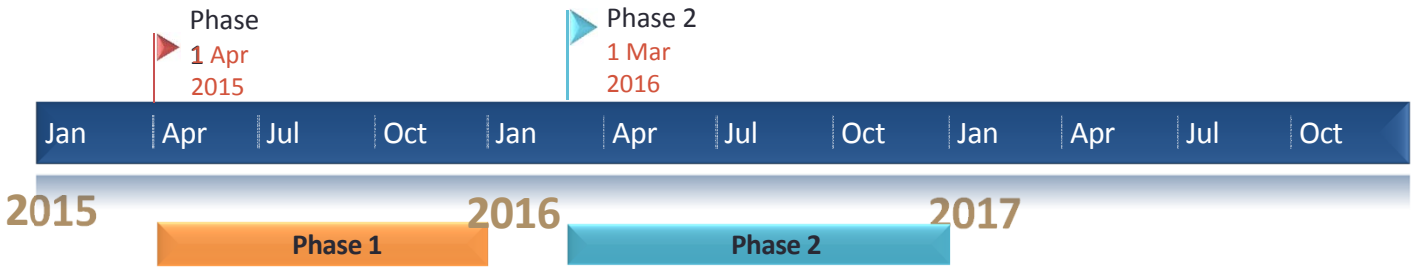
- **Contrast dose**
  - 80ml Omnipaque 350

- **Radiation dose**
  - 2102.5mGycm

Phase 2

- To evaluate the ***radiation dose*** and ***diagnostic quality*** of contrast CT abdominal aortogram after implementation of the low-contrast low-kV protocol.

- 1st March 2016 – 30th November 2016 inclusive (9-month period)



Phase 2

Scanning Protocol

- IV contrast dose: **60ml Omnipaque 350mg/ml** → 30ml saline flush
- Tube voltage: **100kV**

Data Collection and Analysis

- Patient demographics
- Radiation doses
- Image quality
  - Quantitative and Qualitative assessment

Results

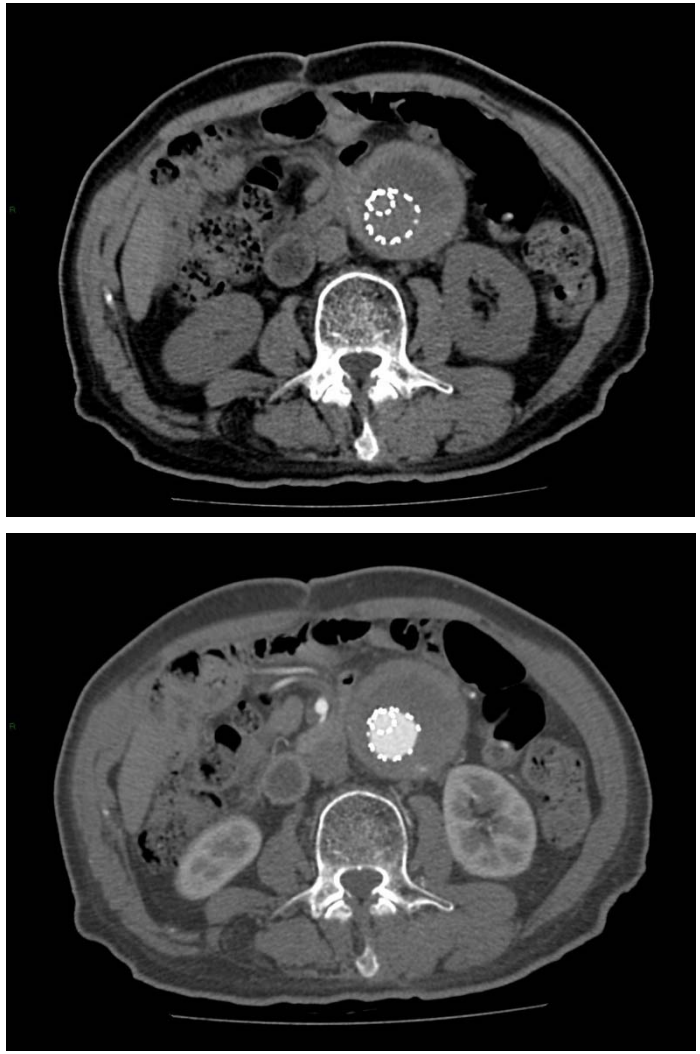
- **Contrast dose**
  - All patients received a ***reduced IV contrast medium*** (Omnipaque 350mg/ml) from 80ml to 60ml (***reduction of 25%)***

- **Radiation dose**

	Phase 1 (120kV)	Phase 2 (100kV)
Mean DLP	2102.5mGycm	1866.3mGycm

Phase 2

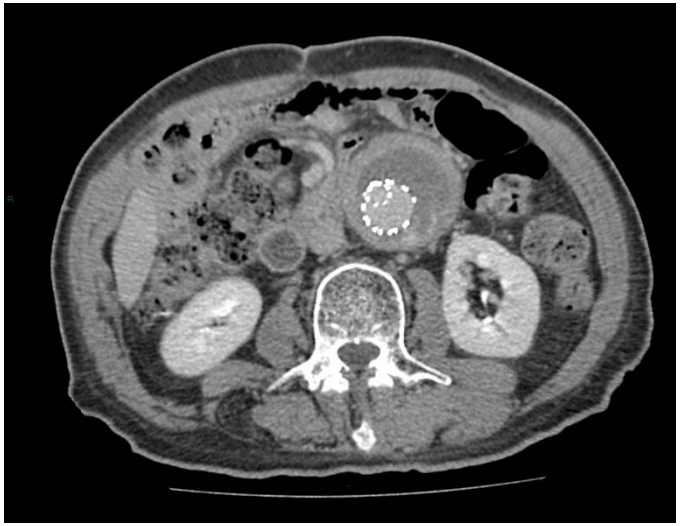
Phase 1 CT images



Phase 2 CT images

Phase 2

Phase 1 CT image



Phase 2 CT image

Results

Image Quality

- No statistically significant differences:
  1. Quantitative parameters
  2. Visual assessment

- Diagnostic image quality was maintained.

Phase 2 – Discussion

- After introduction of the new low-contrast low-kV protocol,
  1. both contrast and radiation doses in the triphasic contrast CT abdominal aortogram examinations were reduced
  2. comparable diagnostic image quality maintained

- The radiation dose could further reduce,
  - Adjustment of the scanning protocol and re-audit

Phase 3

- To further reduce the radiation doses of triphasic contrast CT abdominal aortogram examinations through adjustment of technical scanning parameter while maintaining comparable and satisfactory diagnostic image quality.

- 1st January 2017 – 30th September 2017 inclusive (9-month period)

Phase 3

Scanning Protocol

- IV contrast dose: 60ml Omnipaque 350mg/ml → 30ml saline flush
- Triphasic scans: pre-contrast, arterial and delayed (2-minute after contrast injection)
- Tube voltage: 100kV
- Tube current:
  - ***Pre-contrast & arterial: Low-dose protocol AEC (Sure Exp 3D® Low Dose)***
  - Delayed: Standard protocol AEC (Sure Exp 3D® Standard)

Phase 3 – Results

- Radiation dose

	Phase 2	Phase 3
Mean DLP	1866.3mGycm	1721.0mGycm

- The radiation dose is further reduced.

Phase 3 – Results

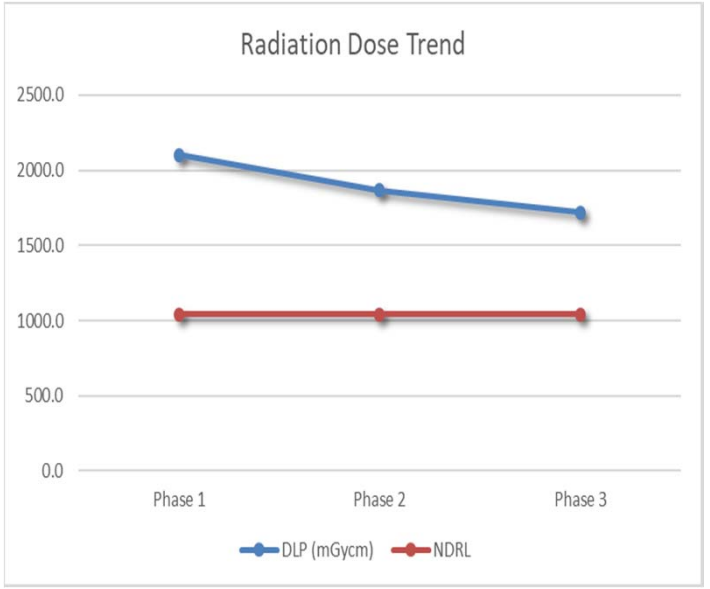
- Image Quality
  - Increase quantitative image noise
    - Arterial phase: 30.5% (p=0.04); delayed phase: 14.6% (p=0.48)
  - Other quantitative and qualitative parameters of image quality: no statistically significant differences

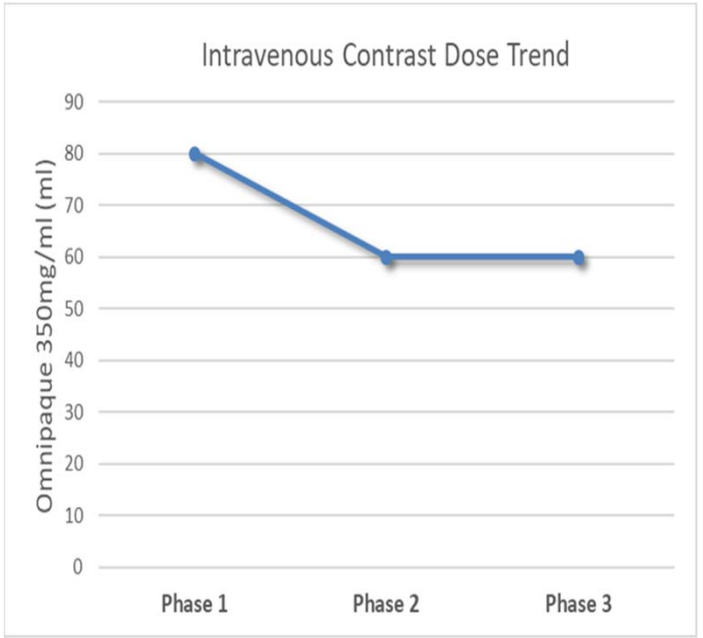
	Phase 2	Phase 3	p-value
Quantitative Image Quality			
Attenuation of aorta (HU)			
Arterial	398.9 ± 55.3	412.4 ± 91.0	0.19
Delayed	138.8 ± 14.1	141.9 ± 26.0	0.73
Attenuation gradient (HU)			
Arterial	11.3 ± 9.8	16.7 ±17.3	0.27
Delayed	6.6 ± 5.8	6.8 ± 5.5	0.81
CNR			
Arterial	27.2 ± 5.6	26.9 ± 10.6	0.87
Delayed	6.4 ± 1.6	6.7 ± 3.2	0.72
Image noise (HU)			
Arterial	12.8 ± 2.2	16.7 ± 6.6	0.04
Delayed	12.3 ± 2.1	14.1 ± 3.7	0.048
Qualitative Image Quality			
Image noise			
Arterial	1.1 ± 0.3	1.1 ± 0.4	1.00
Delayed	1.9 ± 0.3	1.9 ± 0.3	1.00
Image artefact			
Arterial	1.9 ± 0.3	1.9 ± 0.2	0.40
Delayed	1.9 ± 0.3	2.0 ± 0.2	0.09
Overall diagnostic quality			
Arterial	4.0 ± 0.4	4.0 ± 0.2	0.98
Delayed	4.1 ± 0.5	3.9 ± 0.4	0.23

Phase 3 Discussion

- A ***downward trend of radiation doses*** of triphasic contrast CT abdominal aortograms was demonstrated.

- There was an increase in objective measurement of image noise, but unlikely to be clinically significant
  - Minimal increase in absolute value (<5HU)
  - No statistically difference in visual assessment score for image noise





Phase 3 – Discussion

- Limitations :
  - ***Relatively small sample size*** → limiting the power of dose reduction assessment.
  - ***Increase in scan range during latter part of audit cycle*** in response to feedback from vascular surgeons.
    - Pre-contrast & arterial: diaphragm to mid-pelvis → to inguinal (include entire pelvis)
    - Delayed: endovascular stent
  - → Likely both contributing to ***underestimation of degree of radiation dose reduction***

Phase 3 – Recommendations

- Collect feedback from radiologists regarding the acceptance of image quality and diagnostic confidence with the current scanning protocol.
- Implementation of the low dose protocol (Sure Exp 3D® Low Dose) in pre-contrast and arterial phases for all contrast CT abdominal aortogram examinations performed in my department.
- Further effort should be made to reduce radiation doses
  - Further optimization of technical imaging parameters for patients with different body sizes
- Liaise with clinicians and encourage alternative non-ionising modalities (e.g. ultrasound) for where appropriate (e.g. stable disease).

THANK YOU FOR YOUR ATTENTION