How to Reduce Radiation Dose in Complex UFE and PAE Procedures

Götz Richter, MD, Medical Director, Katharinenhospital Stuttgart, Germany, shares practical pointers on reducing the radiation dose when performing uterine fibroid embolization (UFE) and prostatic artery embolization (PAE).

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Prof Richter, how did your experience with UFE inform your PAE practice?

Richter: We started offering PAE around six years ago. Katharinenhospital is a center for multidisciplinary uterine fibroid treatment and we have vast experience with UFE, which we began offering to patients in 1999. There are significant similarities between the male and female vascular anatomies, although the uterine artery is usually a much larger vessel than the arterial supply to the prostate gland. PAE is similar to UFE, but much more complex. Still, we have found very high rates of patient satisfaction with the procedure as it is virtually painless for patients and the hospital stay is very short.

The improvement in clinical symptoms, although slower than with resection, is clear and the procedure is satisfactory to patients in around 90% of cases, as measured using several objective parameters.

What does your research show with regard to dose optimization achieved by changing procedural and imaging aspects?

Richter: A very recent (April 30, 2019) evaluation of the dose area products of all our UFE patients (27) reveals that the radiation dose has dropped significantly to an average of 654 cGy·cm^2 (range 198-3,071) by changing imaging aspects. In 2016, we published our dose area product (DAP) for UFE procedures. On average values, our values were a little over 1,100 cGy·cm^2. In 2017, having included 43 patients (with an average body mass index of 21.7), it was calculated to be 961 cGy·cm^2. This significant reduction was achieved by reducing the number of digital subtraction angiography (DSA) runs and replacing them with fluoroscopy.

In order to position the catheter, we can then use 2D overlay techniques after choosing a well-contrasted image from the fluoro run as provided by our Artis zeego* system.

In PAE patients, the DAP is usually higher as we apply cone-beam CT prior to the procedure, so we reach an average of around 6,500 cGy·cm^2. We do not perform prior pelvic CT examinations, as some other institutions do, because this contributes to a higher radiation dose.

A Recipe for Dose Reduction

Standardized procedural steps in a high-volume setting

1 Patient preparation
Placement of a Foley catheter on the morning of the procedure.

2 Premedication 30 minutes prior to puncture
Intravenous application of 250 mg prednisolone, 4 mg ondansetron, 1.25 mg midazolam, 1 g novamine and 7.5 mg piritramide.

3 Angiography system parameters
Selection of the "low-dose pelvis" preset with low-frequency pulsed fluoroscopy (4 pulses/s) and a low frame rate for digital subtraction angiography (DSA) acquisitions (0.5 or 1 image/s).

4 Maintenance of analgesia
This is not necessary.

5 Vascular access
Short 5 F sheath from the right side.

6 Catheterization of the left iliac artery
After reviewing the MRI and MRA (dynamic visualization of pelvic vascular anatomy) and under fluoroscopy guidance (field-of-view of 22 cm; collimation; no tube angulation), catheterization of the main stem of the left internal iliac artery applying a 5 F ROC catheter and a soft glidewire with an angulated tip.

7 Identification of the prostate vessels
DynaCT run: delay 6–8 sec; 30 ml contrast at 2 ml/sec.

8 Reaching the embolization position
Selection of appropriate vessels and application of *syngo* Embolization Guidance software to advance a 2 F coaxial microcatheter system. Intra-arterial spasmolysis (e.g. 0.5 mg nitroglycerine) to the target position.

9 Embolization
Flow-controlled injection of biocompatible calibrated microspheres (Embozene microspheres, CeloNova BioSciences/Boston Scientific) with a size of 250 µm until stasis. Angiographic documentation of stasis.

10 Catheterization of the right iliac artery and prostate vasculature, only if necessary
Before this, there should be careful evaluation of prostate opacification during a DynaCT run from the left iliac artery to identify collateral flow. If present, there is no need for bilateral embolization.

11 Vascular access management
Removal of catheters, sheath, and needle. Patient receives compression and sterile bandages.

12 Follow-up
Removal of the Foley catheter the next morning. MRI for evaluation of devascularization after 10 days. Patient satisfaction and clinical evaluation using standardized questionnaires.

I would strongly recommend that beginners first perform either a high-quality pelvic CT or use cone-beam CT, as we do, to identify the vascular anatomy. Furthermore, high frequency fluoroscopy and DSA should be avoided and collimation should be perfect. Then, the DAP of the procedure alone (i.e., when the dose of cone-beam CT is not taken into account), can and should be below 5,000 cGy·cm^2.

What measures do you recommend for reducing operator dose?

Richter: Before embarking on dose reduction strategies, first and foremost, operators need to achieve an adequate expertise with the pelvic vascular anatomy. Once this is achieved, it is important to set a low frame rate for fluoroscopy (4/s); low frame rate for DSA (1/s or 0.5/s) and the best possible collimations.

Additionally, it is critical to avoid DSA whenever possible by using fluoroscopy overlay technology and to use a minimum number of oblique projections. Whenever possible, it is also useful to employ image fusion guidance. All these measures will result in dose reductions for both the operator and the patient.

Have you established a well-defined PAE workflow at your hospital?

Richter: Our workflow is highly standardized and includes pre-interventional imaging, lab values, objective and symptomatic urologic assessment, which are based on the applicable guidelines. Then, during the procedure (with a Foley catheter) *syngo* DynaCT is used to identify the pelvic vascular anatomy. Embolization is performed with a microcatheter (2–2.7 F) using embolic particles < 400 microns.

Prof Richter, thank you for taking the time to talk with us.

Urmila Kerslake is a Bristol-based journalist. She is the Digital Education Lead and Senior Editor of the specialist quarterly newspaper, Interventional News, with which the content of this article first appeared as part of a supplement.

* The current product is ARTIS pheno.

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