3D Navigation: Why all this technology?

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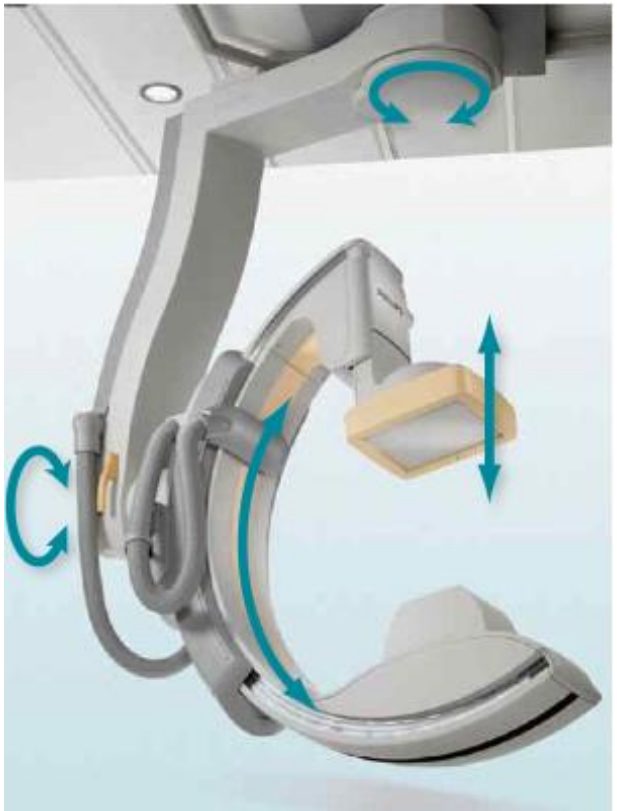
The new operative environment

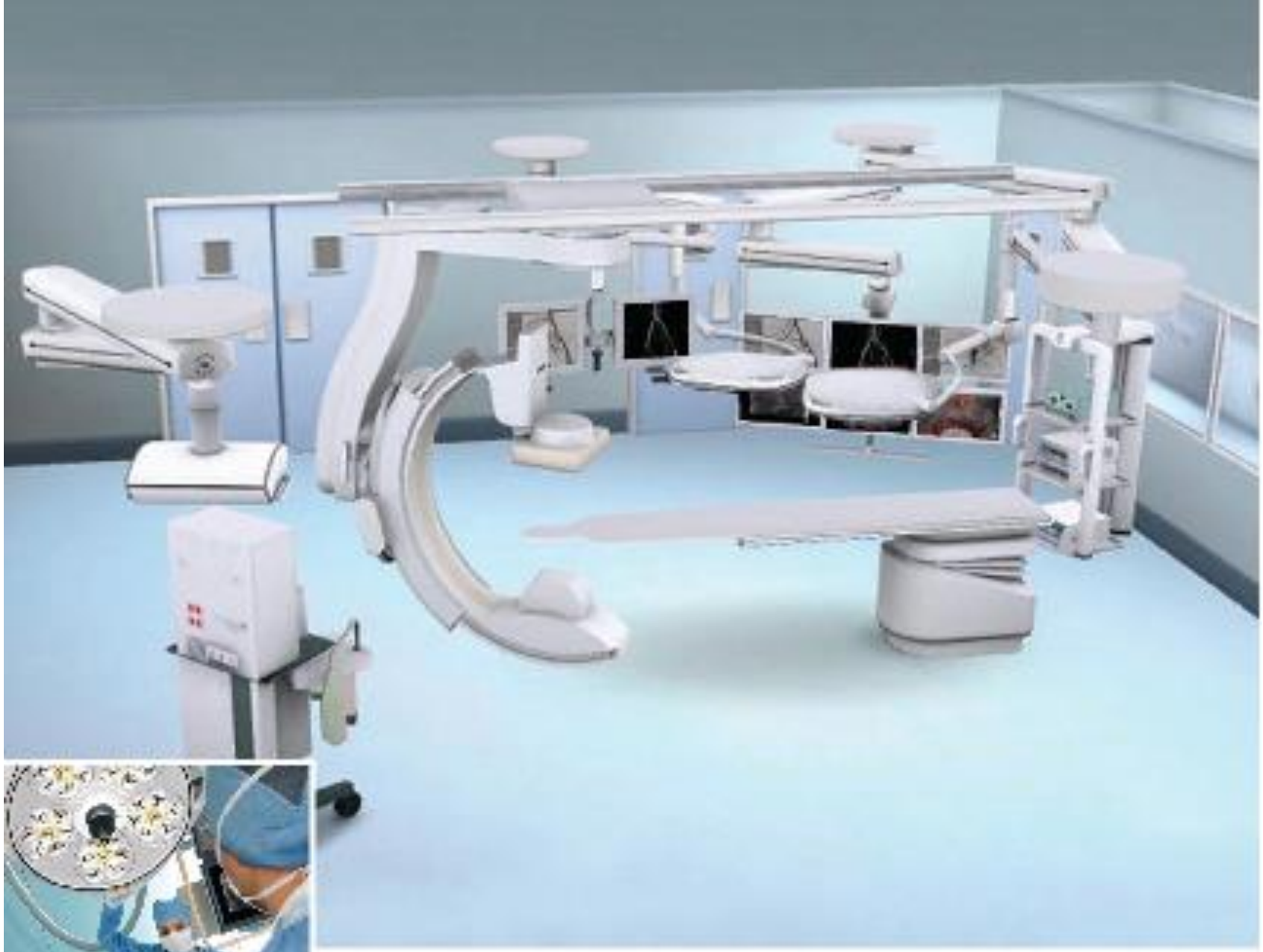
- A fully integrated interventional suite combines surgical sterility with flat-panel C-ARM
- workstation, post processing, and storage facilities.
- The size of the hybrid room should be of sufficient dimensions to allow anesthesiology facilities needed for full patient monitoring
- Equipment available in the room: intravascular ultrasound, 3D transesophageal echocardiogram, rotational angiography
- The ability for open conversion or hybrid intervention and endovascular supplies and devices must be able to fit in

Cost: 1 to 1.5 Million Euros

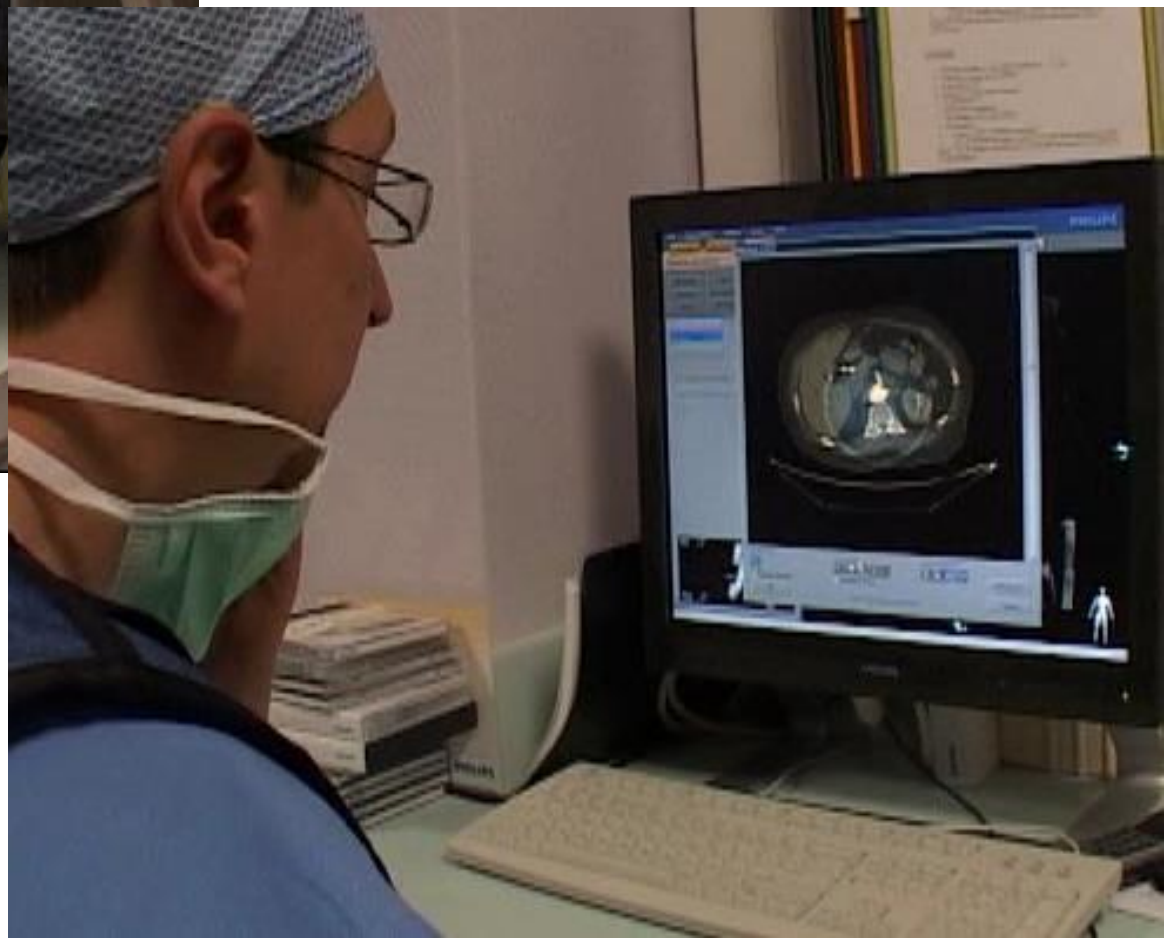
Technology

- Flat Panel: Images with high resolution: 500000 €
- 3D Rotational Angiography: 30000 €
- Cone-beam CT-like: 30000 €
- Multi-modality overlay images: 30000 €
- coupling cone-beam CT technology and integrated tracking and navigation
- This coregistration is integrated with the movement of the C-arm





Hybrid Room equipped with C-arm and Specialty Imaging Table
(Complex, Image-Guided Diagnostic & Surgical Procedures)

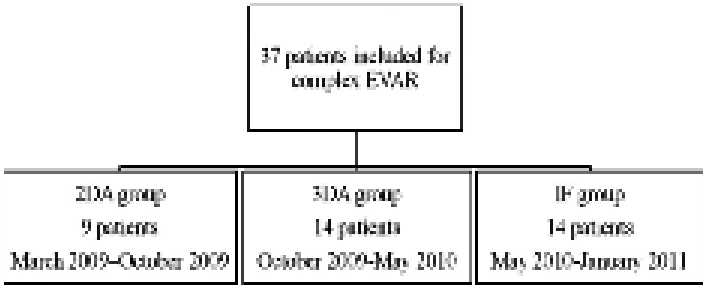


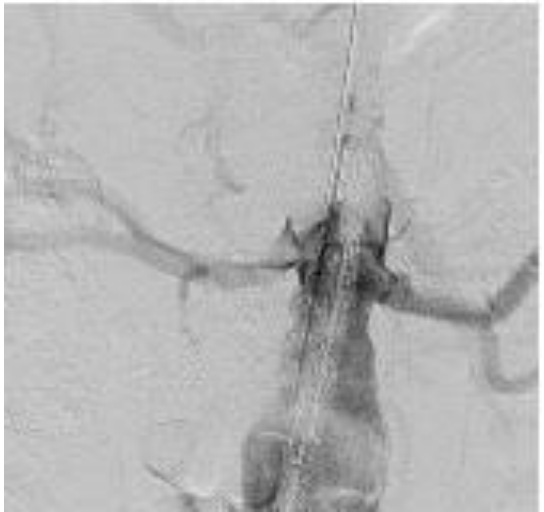
Learning curve: staff
Rotation
Workstation

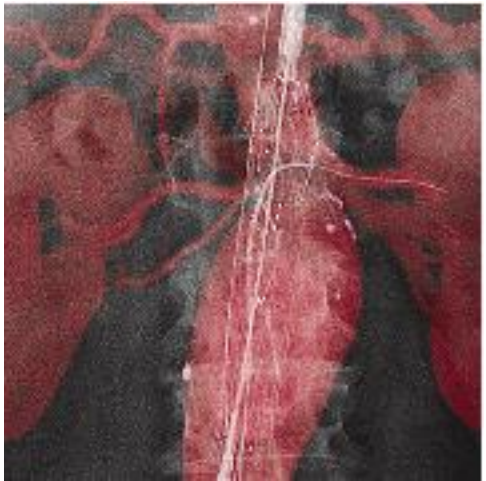
J Vasc Interv Radiol 2013;

Comparison of Two-dimensional (2D) Angiography, Three-dimensional Rotational Angiography, and Preprocedural CT Image Fusion with 2D Fluoroscopy for Endovascular Repair of Thoracoabdominal Aortic Aneurysm

Vania Tacher, MD, MingDe Lin, PhD, Pascal Desgranges, MD, PhD, Jean-Francois Deux, MD, PhD, Thijs Grünhagen, PhD, Jean-Pierre Becquemin, MD, Alain Luciani, MD, PhD, Alain Rahmouni, MD, and Hicham Kobeiter, MD

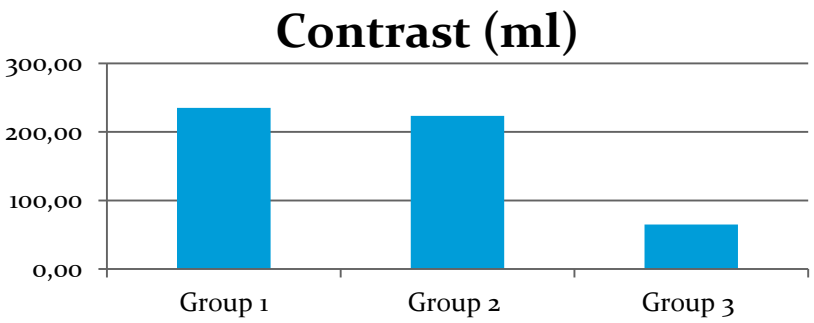


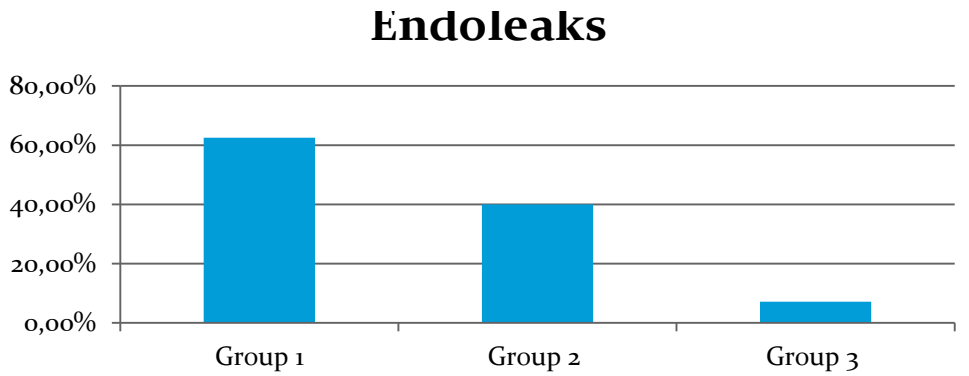




Intervention Data

Parameters (n ± SD or %)	2DA Group n=9	3DA Group n=14	IF Group n=14	p-value
Success of procedure	8(89%)	14(100%)	14(100%)	0.24
Duration of Intervention (minute)	233(±123)	181(±53)	189(±60)	0.59
DAP (Gy×cm²)	1188(±1067)	984(±581)	656(±457)	0.18
Contrast (ml)	235(±145)	225(±119)	65(±28)	<0.0001

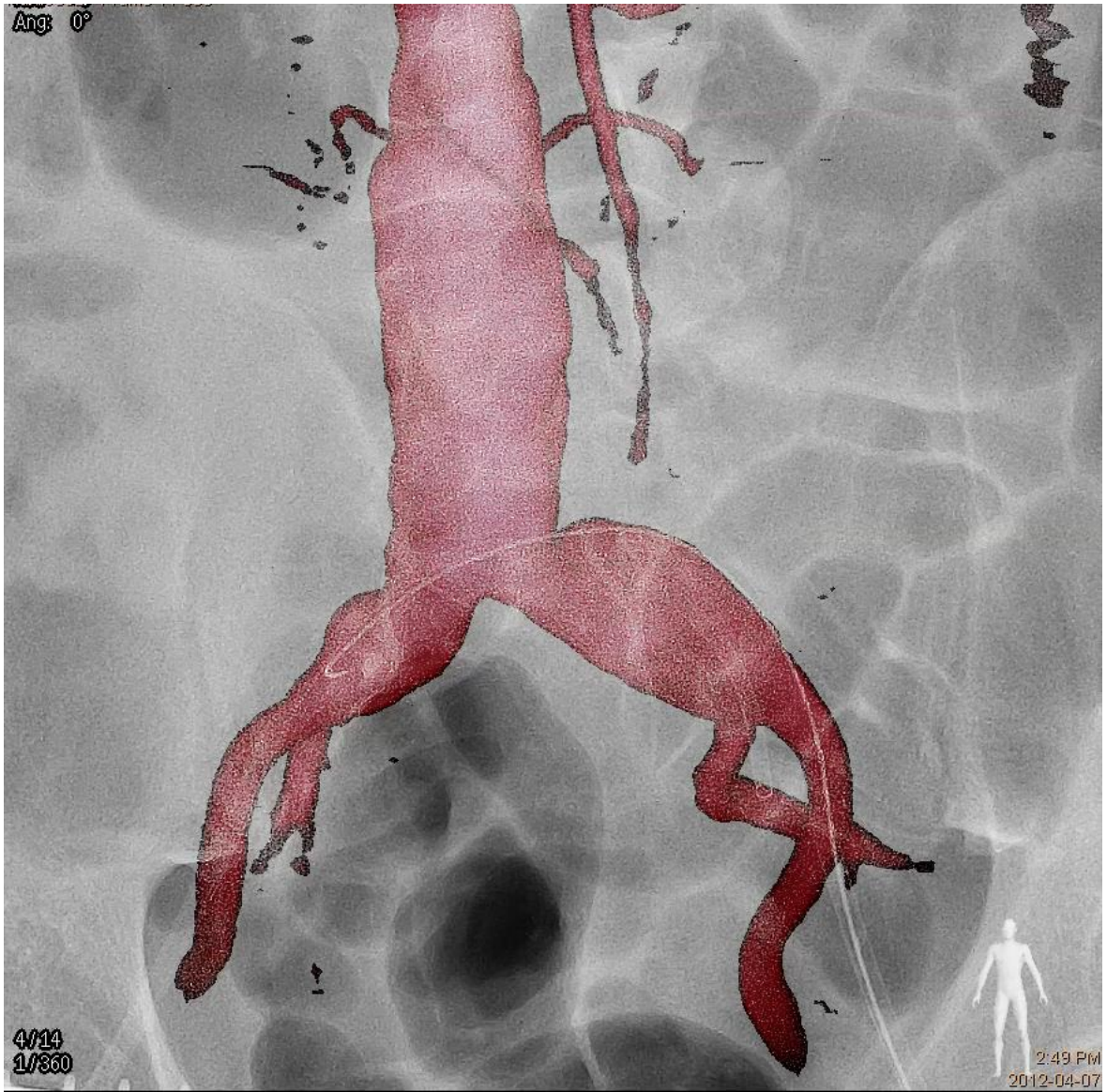




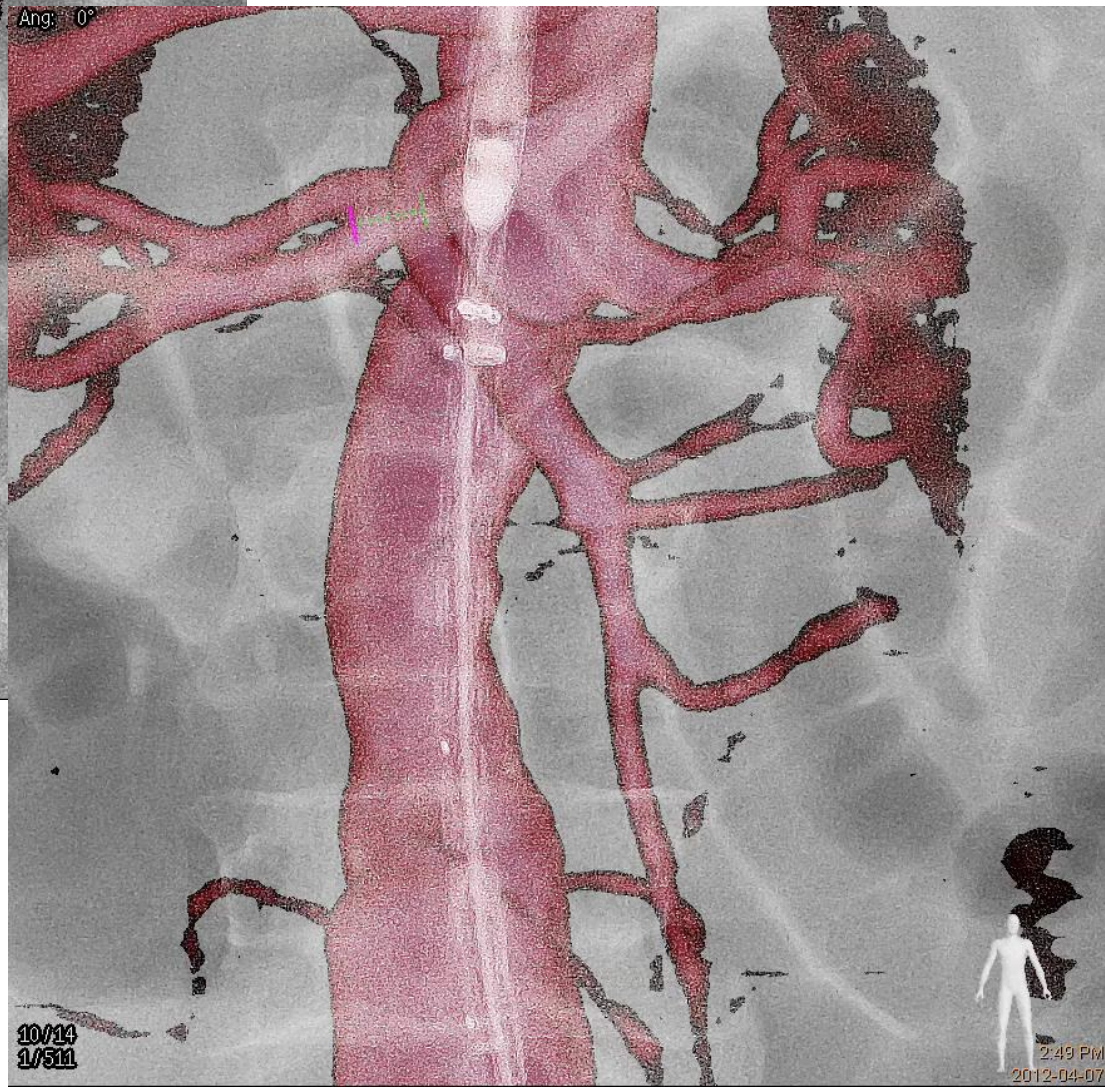
Endoleak on the first CT control	Group 1		Group 2		Group 3	
Endoleak	5	62,50%	6	40,00%	1	7,14%
Type 1	3	37,50%	2	13,33%	0	0,00%
Type 2	2	25,00%	4	26,67%	1	7,14%
Type 3	0	0,00%	0	0,00%	0	0,00%

Application:
AAA symptomatic: 56 mm
MRA No rupture but wall enhancement
Anaphylactic Choc during 2 coronarography «15 stents »

MRA Overlay




Ang: 0°
7/14
1/96


Ang: 0°
10/14
1/511
2:49 PM
2012-04-07

MRA

Symptomatic AAA

Anaphylactic choc to CM: 2 episodes

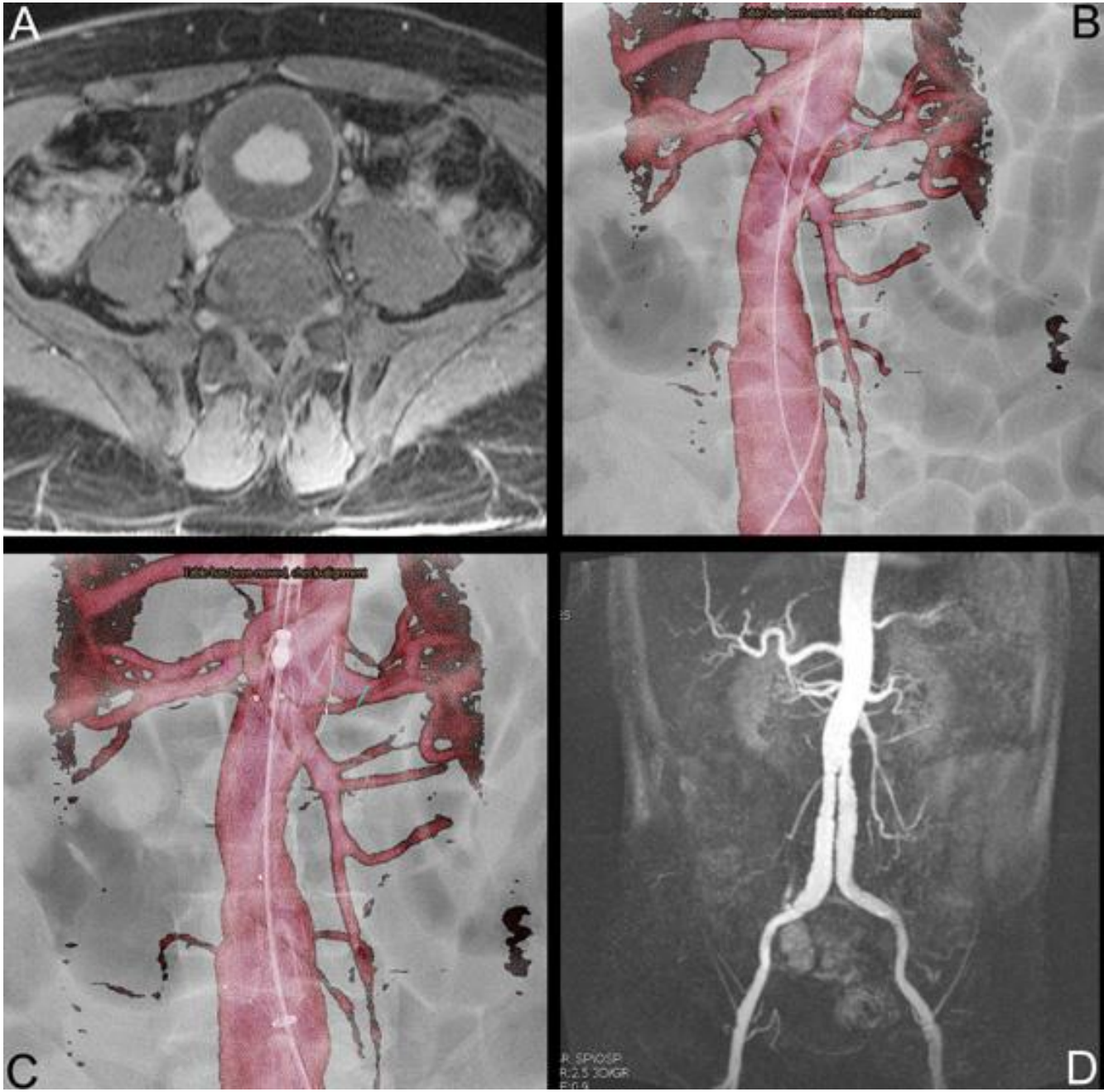
MRA overlay

Intervention: 70 Min

Fluoro: 15 Min

Graphic acquisition: 0

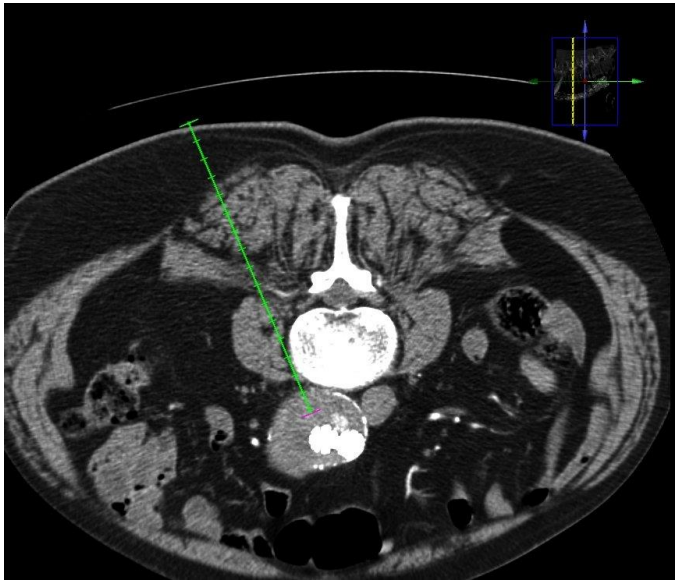
CM: 0cc



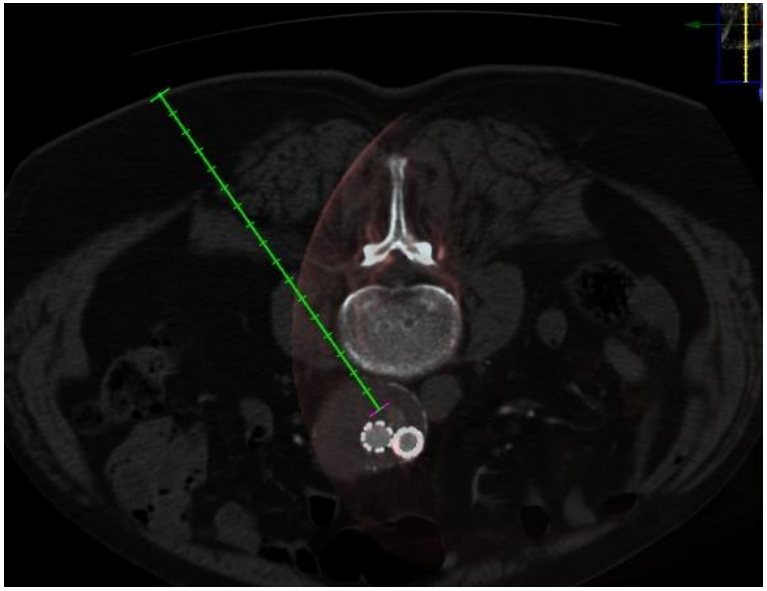
EVAR: Type II endoleaks embolization

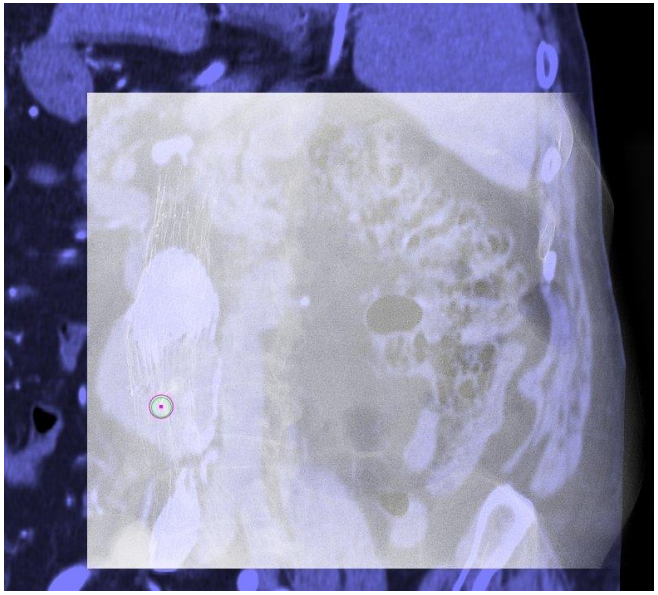
Direct Embolization of the sac

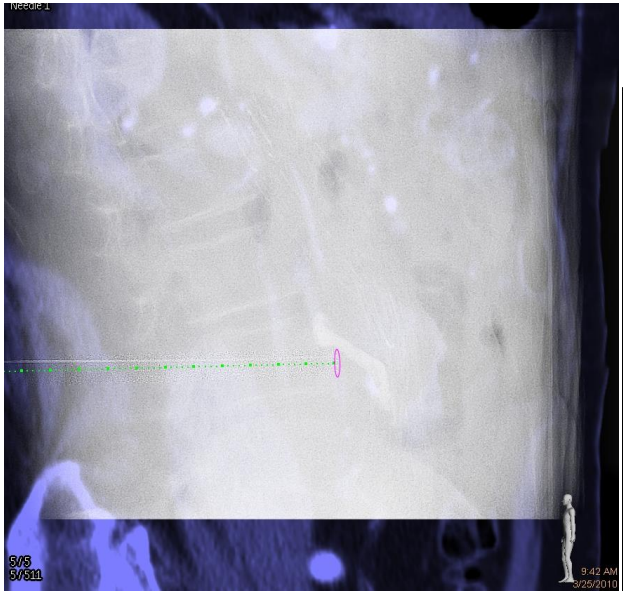
- Stavropoulos et al.: 62 DSE (24 AMI, 35 Lumbar) with 72% of success and 3% of complications
- Nevela et al and Baum et al have published similar results with in shorter series (75% and 92% of success)
- Time >/= 1h
- Van Brinsdsbergen et al and Blinker et al: discribed the technique with CBCT guidance in the angio-room reducing time and X-Ray esposure: 35 min

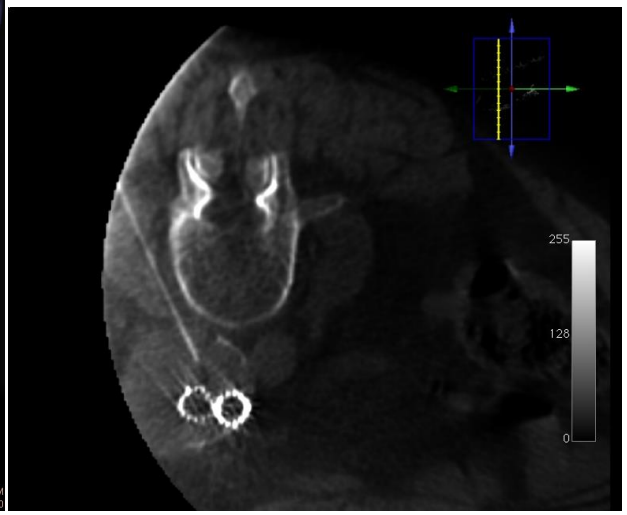


Overlay:
CT and CBCT





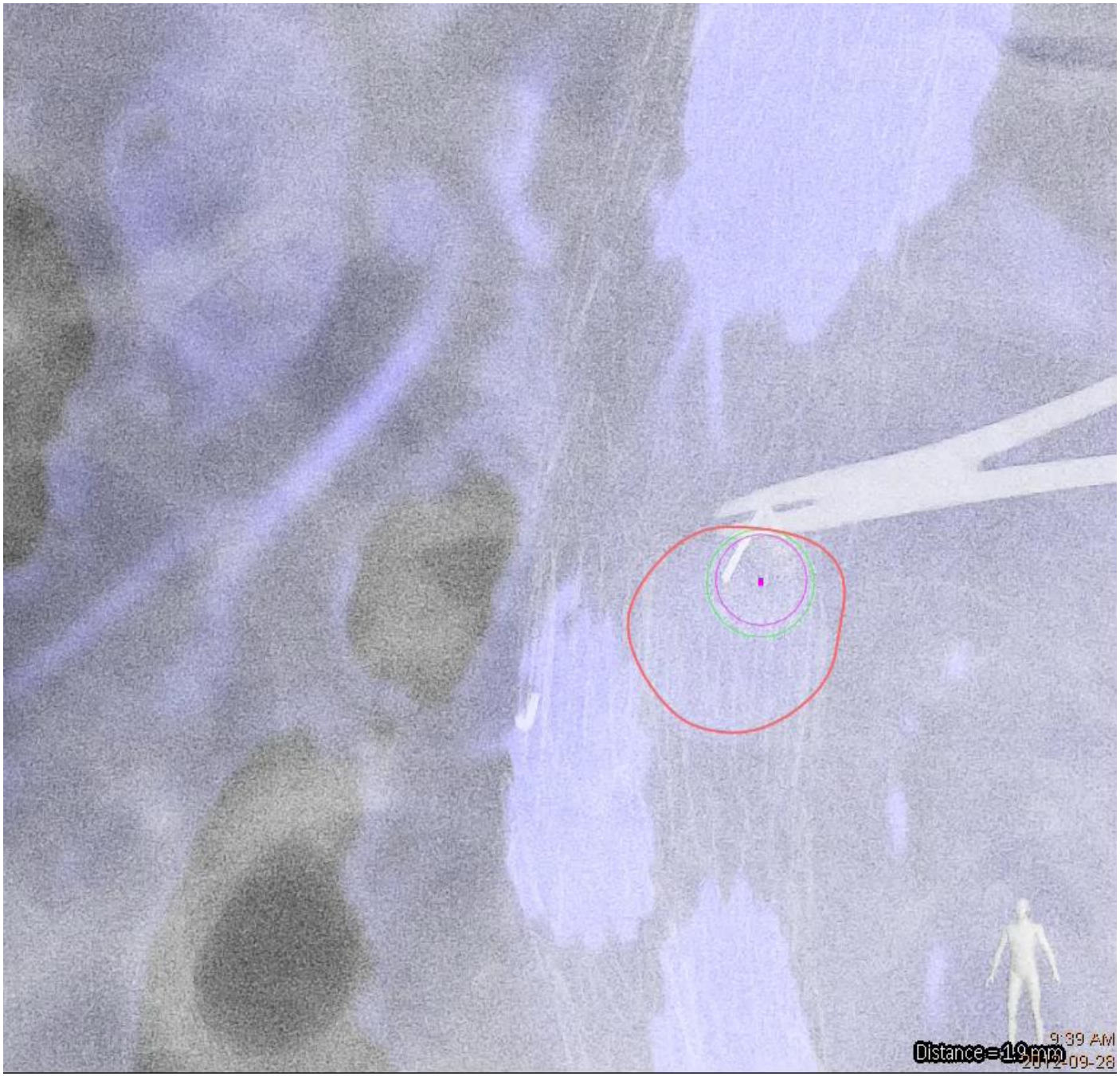




Entry point of view

Progress view

confirmation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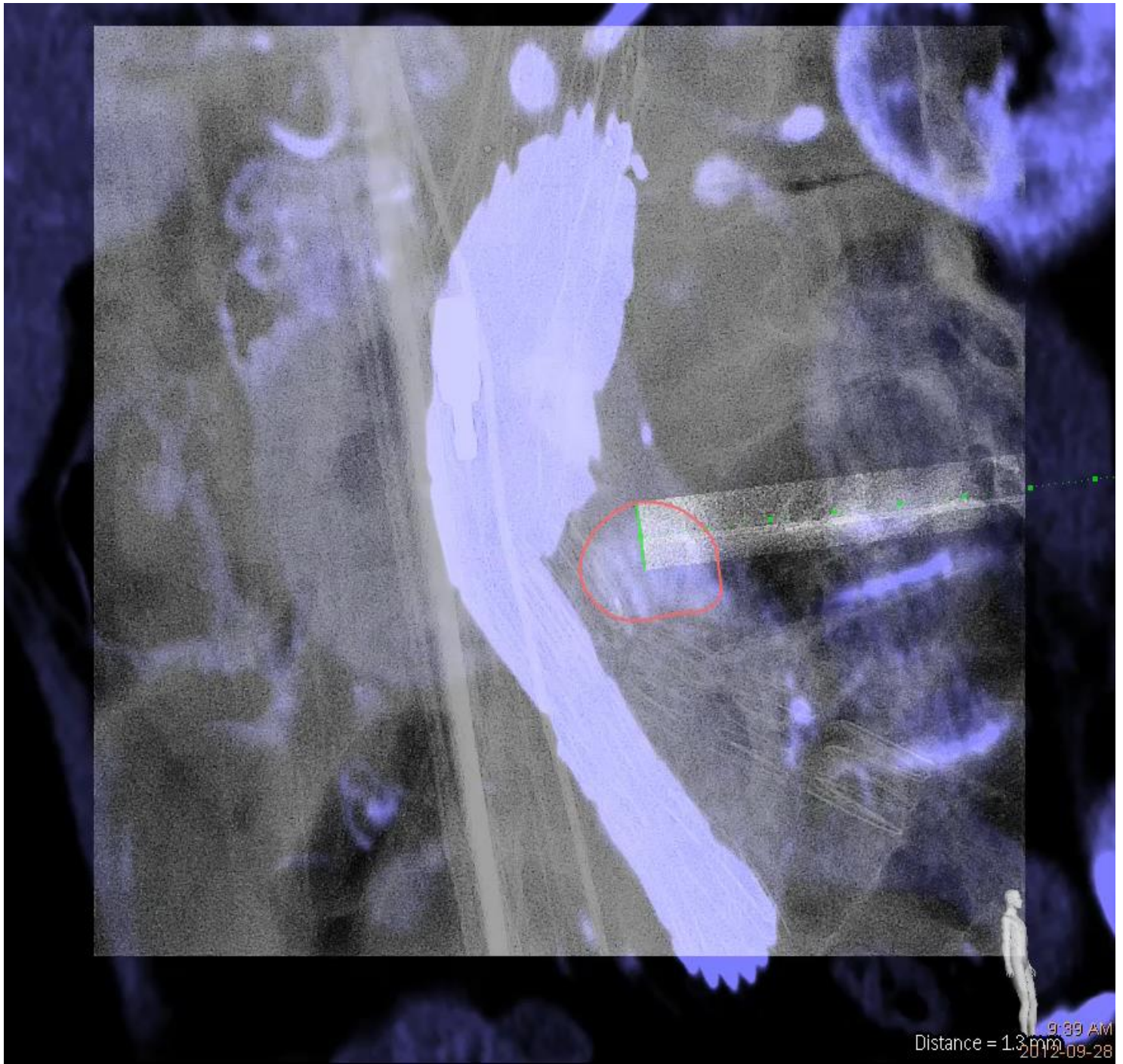
2022-09-28


Distance = 1.3 mm
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2012-09-28

embolization guidance

propeller movement

roll movement

Role of CBCT in TACE-Survival

Contents lists available at SciVerse ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

2012

Survival after C-arm CT-assisted chemoembolization of unresectable hepatocellular carcinoma

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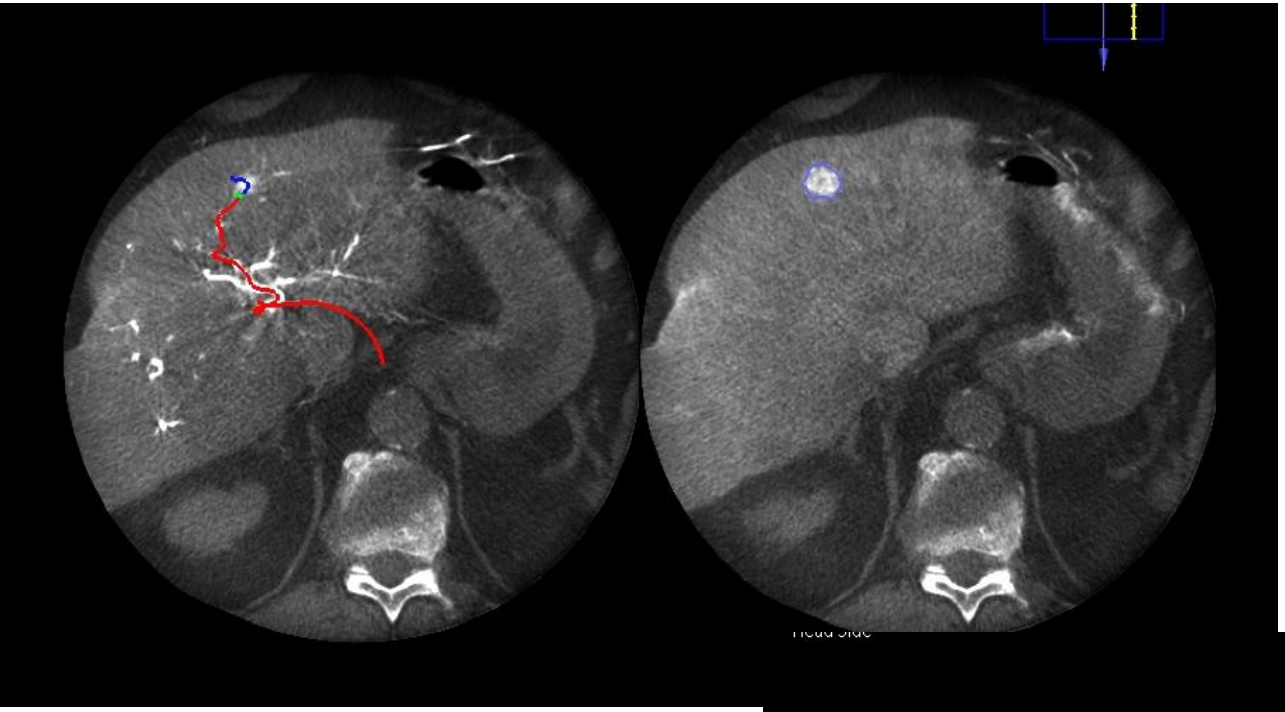
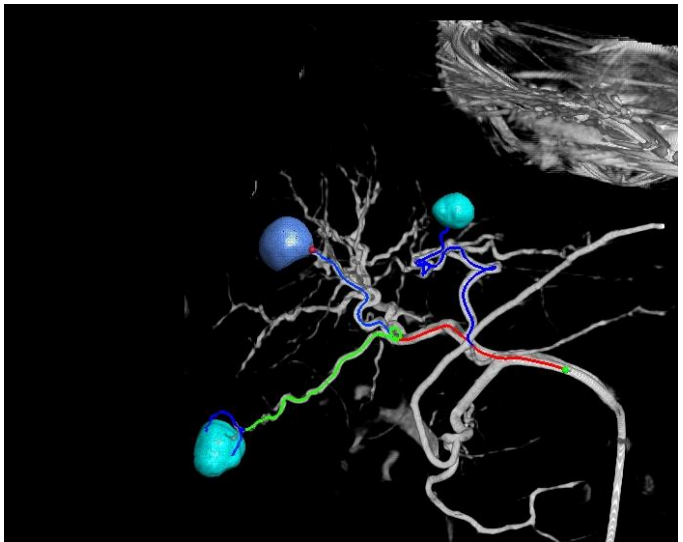
[b] *Department of Radiology, Komatsu Hospital, 11-6 Kawakatsucho, Neyagawa 572-8567, Japan*
[c] *Department of Gastroenterology, Nissay Hospital, 6-3-8 Itachibori, Nishiku, Osaka 550-0012, Japan*

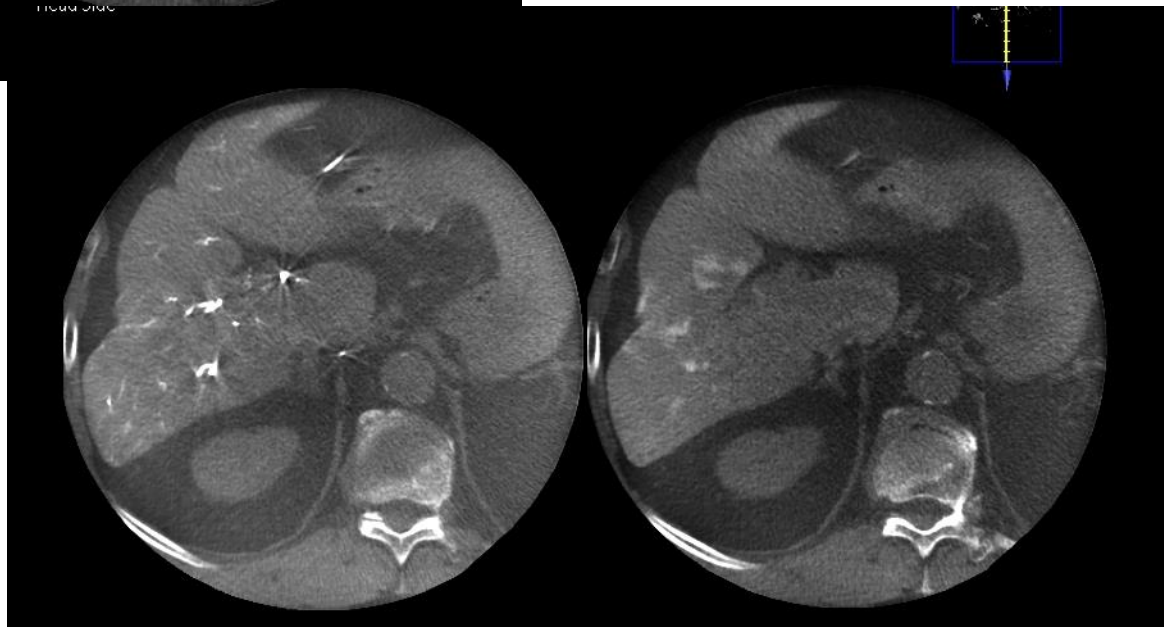
Retrospective study, 130 patients

- CBCT assistance is an independent factor associated with:
  - Longer overall survival
    (hazard ratio, 0.40; P = 0.033)
  - Longer local progression-free survival
    (hazard ratio, 0.25; P = 0.003)

TACE Guidance







Utility of Cone-beam CT Imaging in Prostatic Artery Embolization

Sandeep Bagla, MD, Kenneth S. Rholl, MD, Keith M. Sterling, MD,

J Vasc Interv Radiol 2013,

ABSTRACT

Purpose: To evaluate the utility of cone-beam computed tomography (CT) in patients undergoing prostatic artery (PA) embolization (PAE) for benign prostatic hyperplasia.

Materials and Methods: From January 2012 to January 2013, 15 patients (age range, 59–81 y; mean, 68 y) with moderate- or severe-grade lower urinary tract symptoms, in whom medical management had failed were enrolled in a prospective United States trial to evaluate PAE. During pelvic angiography, 15 cone-beam CT acquisitions were performed in 11 patients, and digital subtraction angiography was performed in all patients. Cone-beam CT images were reviewed to assess for sites of potential nontarget embolization that impacted therapy, a pattern of enhancement on cone-beam CT suggesting additional PAs, confirmation of prostatic parenchymal perfusion before embolization, and contralateral prostatic parenchymal enhancement.

Results: Cone-beam CT was successful in 14 of 15 acquisitions, and PAE was successful in 14 of 15 patients (92%). Cone-beam CT provided information that impacted treatment in five of 11 patients (46%) by allowing for identification of sites of potential nontarget embolization. Duplicated prostatic arterial supply and contralateral perfusion were each identified in 21% of patients (three of 11). Prostatic perfusion was confirmed before embolization in 50% of acquisitions (seven of 14).

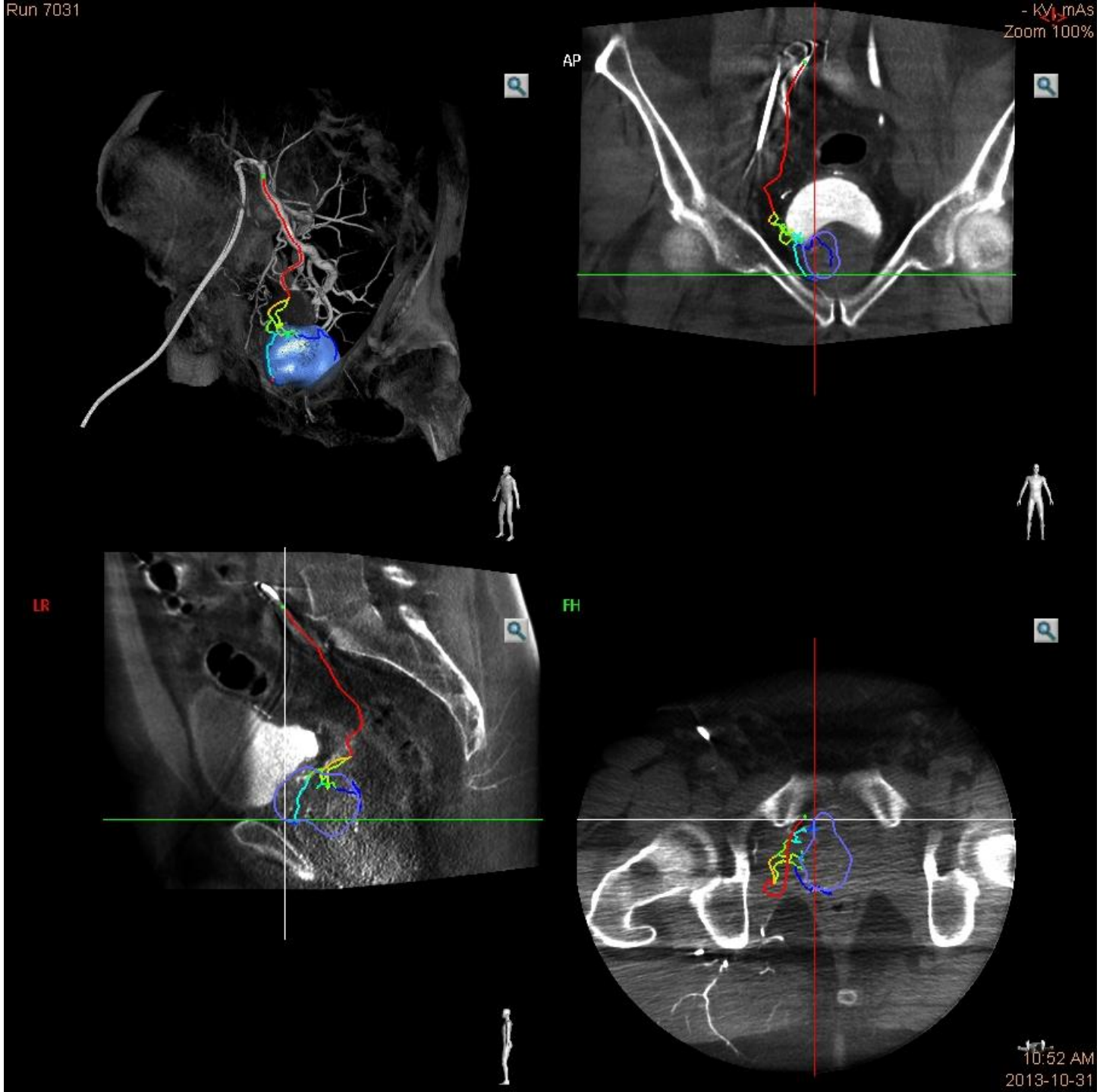
Conclusions: Cone-beam CT is a useful technique that can potentially mitigate the risk of nontarget embolization. During treatment, it can allow for the interventionalist to identify duplicated prostatic arterial supply or contralateral perfusion, which may be useful when evaluating a treatment failure.

Table 2. Potential Sites of Nontarget Embolization Identified with Cone-beam CT

Site	Incidenc
Bladder	2 (14)
Rectum	2 (14)
Penis	1 (7)
Seminal vesicles	1 (7)
Pelvic/thigh musculature	1 (7)

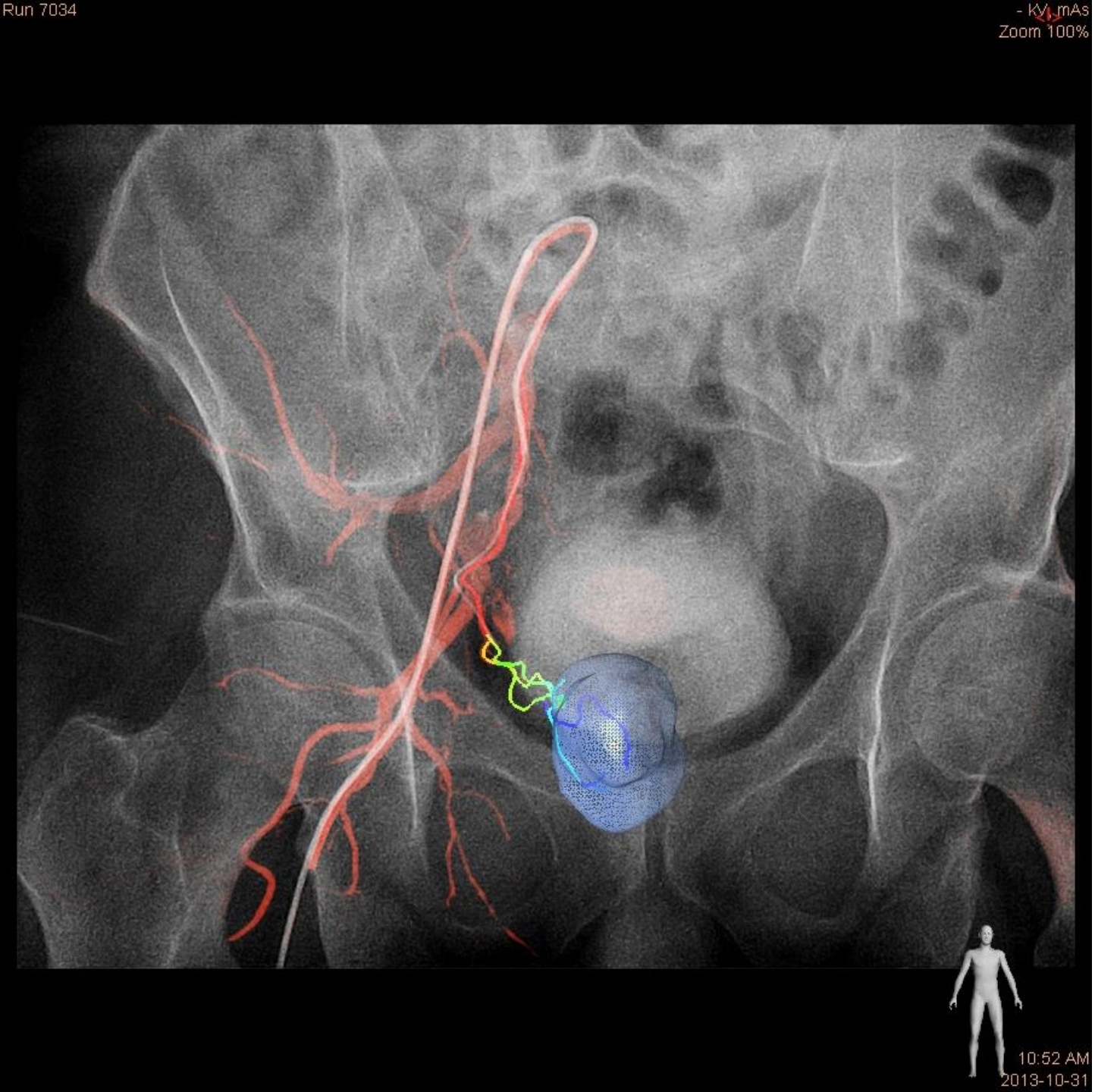
Arterial phase

Delayed phase
And segmentation of the enhanced part

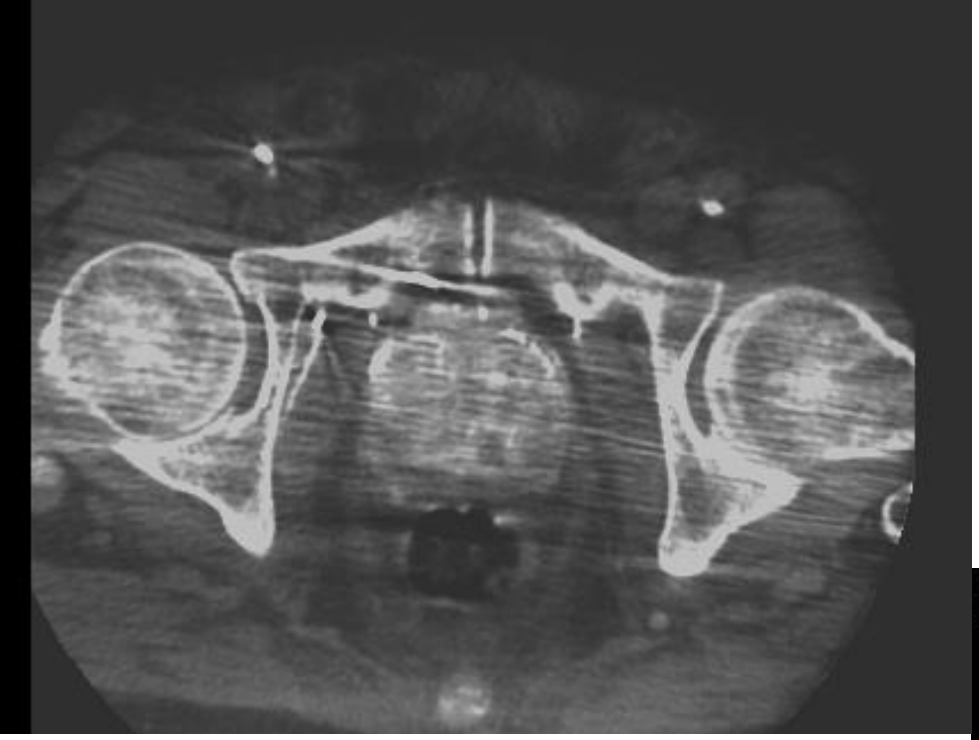


Emboguide Software: central line extraction

3D and coronal, sagittal and axial view



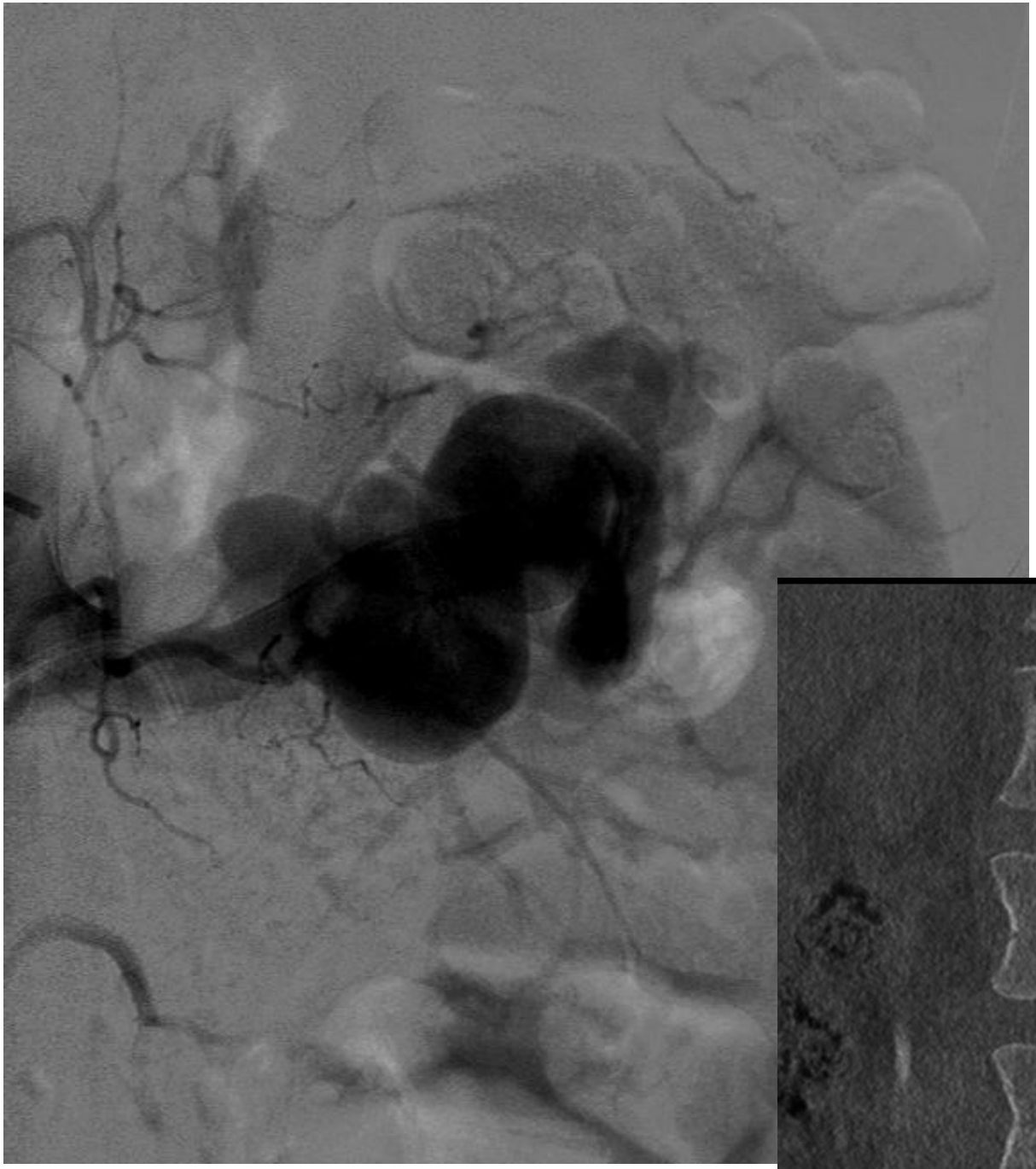
3D Arterial view overlaid with the 3D segmentation the CL path and the fluoroscopy



Selective injection in the PA feeder
Enhancement of the all prostatic gland

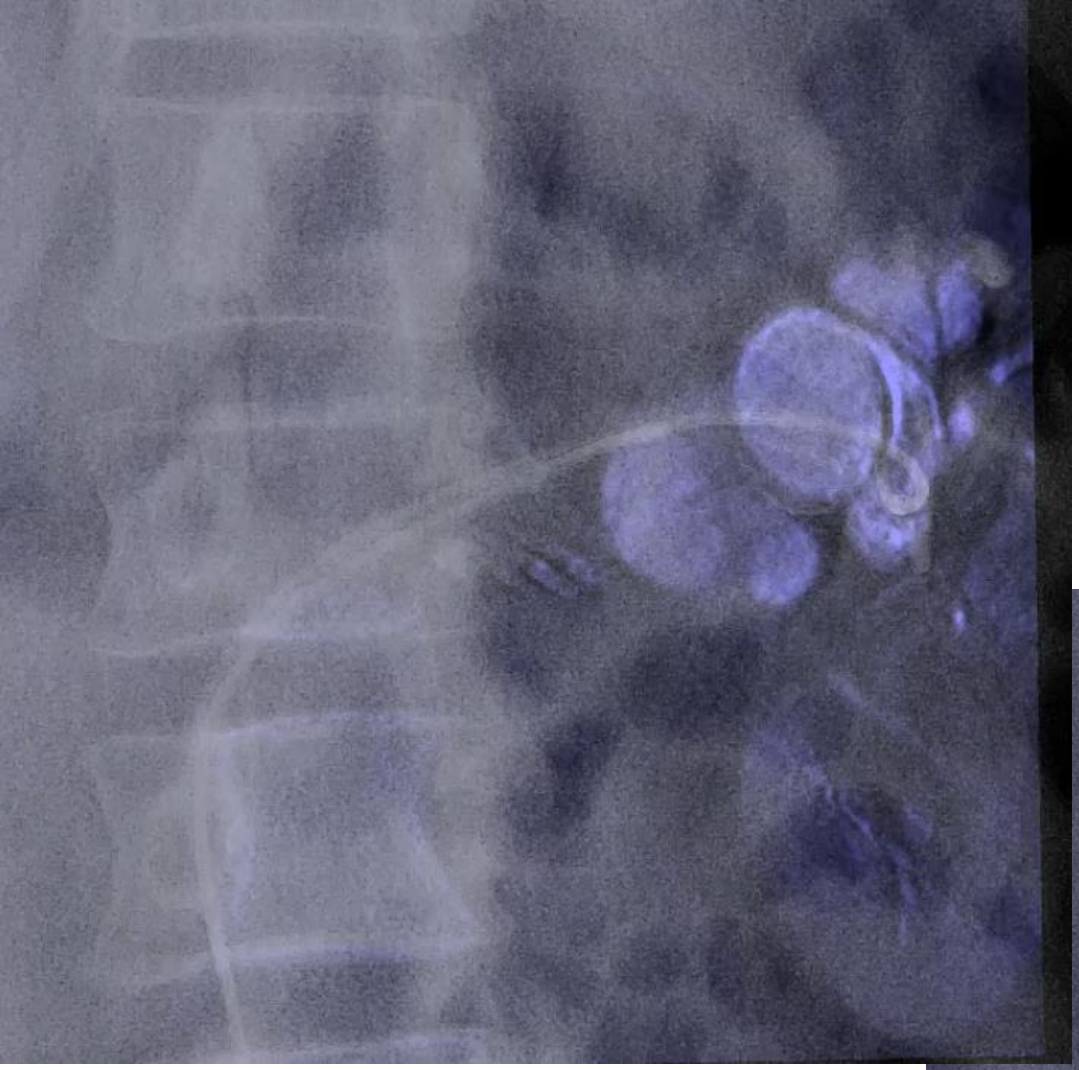
Control post-embolization

Men of 57 Y/O
HBP
US-Doppler and CTA
Large AVM in left kidney

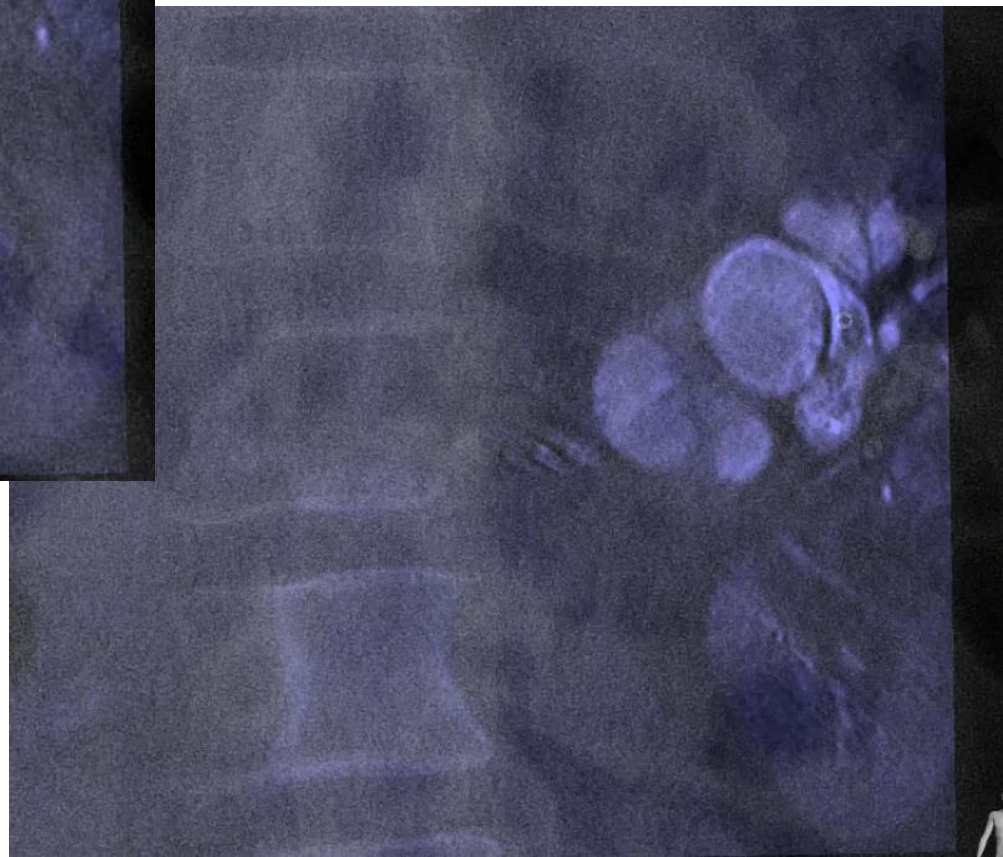


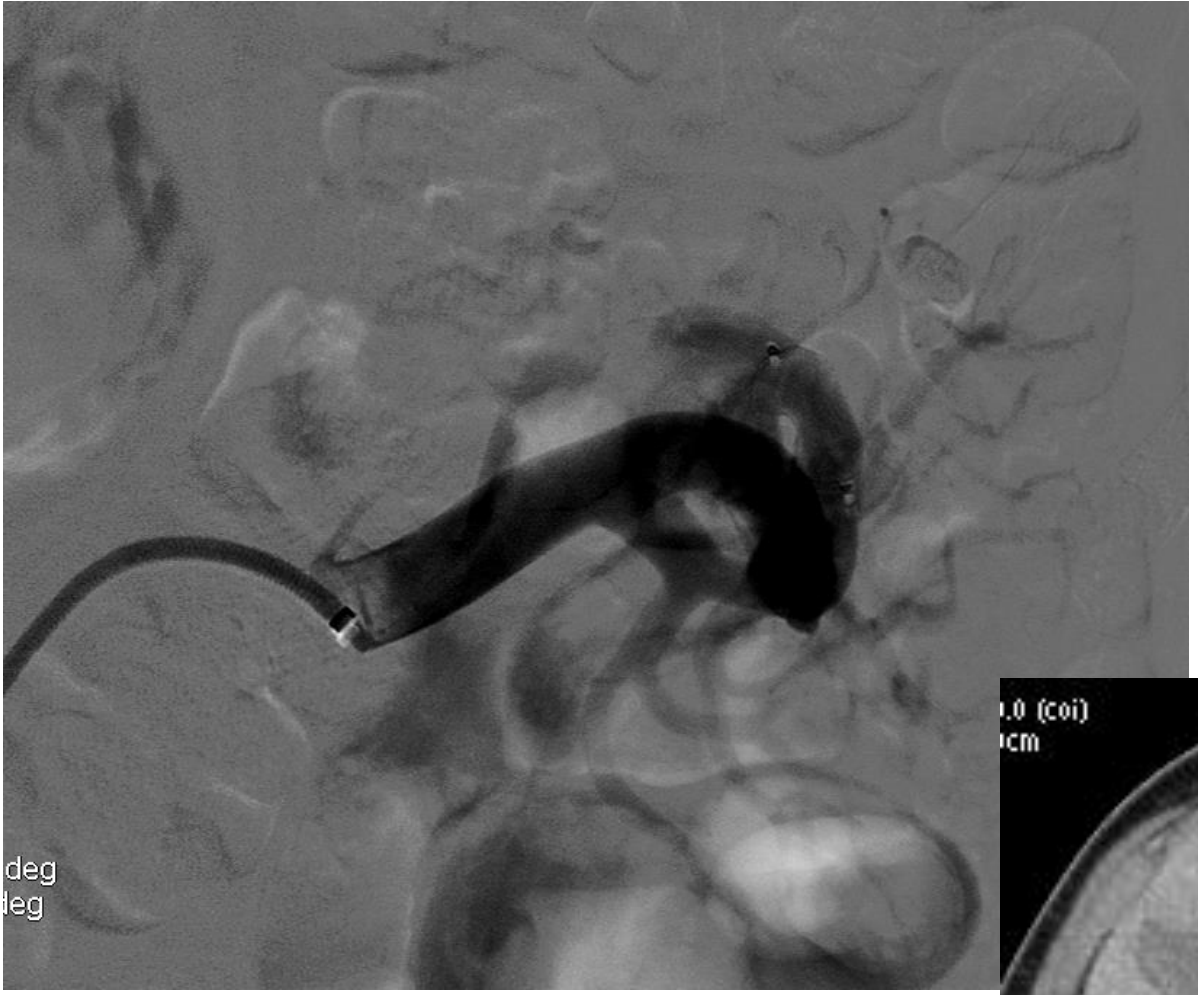
DSA: Difficulties to identify the feeder

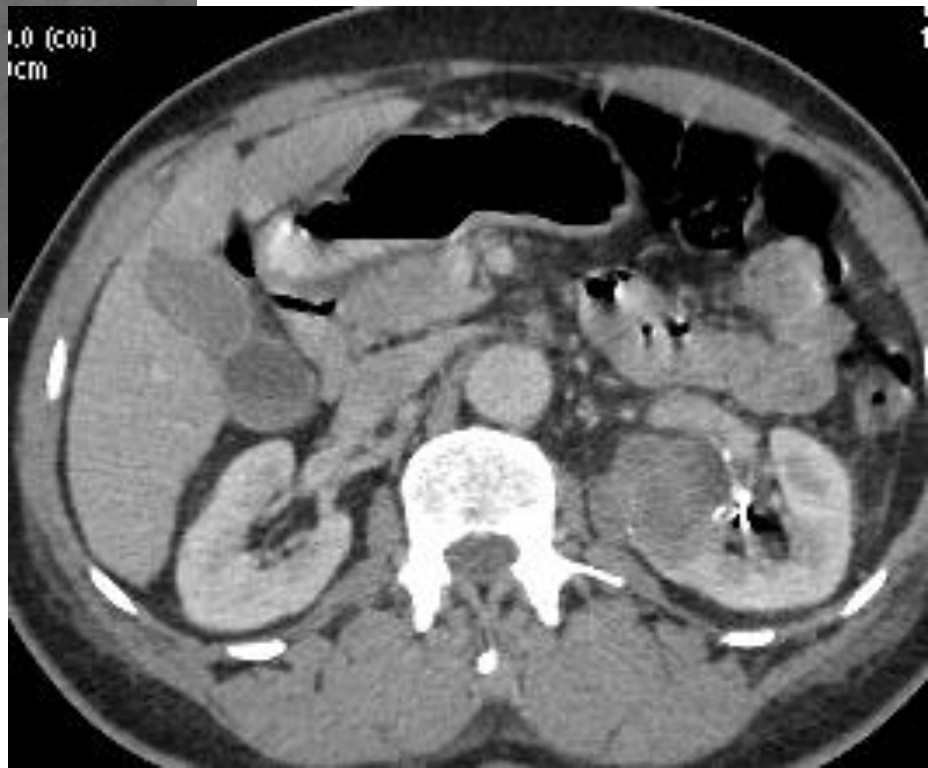
Decision to do a arterial CBCT



Positioning of a long 6 Fr sheath within the feeding artery







Embolization with a 10 mm diameter Amplatzer I

Literature

1: Floridi C, Radaelli A, Abi-Jaoudeh N, Grass M, De Lin M, Chiaradia M, Geschwind JF, Kobeiter H, Squillaci E, Maleux G, Giovagnoni A, Brunese L, Wood B, Carrafiello G, Rotondo A. C-arm cone-beam computed tomography in interventional oncology: technical aspects and clinical applications. Radiol Med. 2014 Jul

2: Tacher V, Lin M, Desgranges P, Deux JF, Grünhagen T, Becquemin JP, Luciani A, Rahmouni A, Kobeiter H. Image guidance for endovascular repair of complex aortic aneurysms: comparison of two-dimensional and three-dimensional angiography and image fusion. J Vasc Interv Radiol. 2013 Nov

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4: Alomran F, Desgranges P, Majewski M, You K, Kobeiter H. Image fusion for hybrid repair of dislocated superior mesenteric branch of a branched endovascular aortic graft. J Vasc Surg. 2013 Sep

5: Abi-Jaoudeh N, Kruecker J, Kadoury S, Kobeiter H, Venkatesan AM, Levy E, Wood BJ. Multimodality image fusion-guided procedures: technique, accuracy, and applications. Cardiovasc Intervent Radiol. 2012 Oct

6: Kobeiter H, Nahum J, Becquemin JP. Zero-contrast thoracic endovascular aortic repair using image fusion. Circulation. 2011 Sep

JVIR

BRIEF REPORT

Automatic Thre-Dimensional Detection of Prostatic Arteries Using Cone-Beam CT During Prostatic Arterial Embolization

Mélanie Chiaradia, MD, Alessandro Radaelli, PhD, Alexandre Campeggi, MD, Mohamed Bouanane, MD, Alexandre De La Taille, MD, PhD, and Hicham Kobeiter, MD

ABSTRACT

The purpose of this study was to evaluate the automatic three-dimensional detection of prostatic arteries (PAs) with the use of dual-phase cone-beam computed tomography (CT) imaging and vessel-tracking software during prostatic artery (PA) embolization (PAE). In six patients, six right PAs and five left PAs were detected by using the software (sensitivity, 92%). The false-positive arteries (right side, 14%; left side, 25%) were deleted after cone-beam CT review. Automatic software detection of PAs from cone-beam CT may permit identification of the PA during PAE.

Literature

- Evaluation of automated 2D-3D image overlay system utilizing subtraction of bone marrow image for EVAR: feasibility study. Fukuda T. Eur J Vasc Endovasc Surg. 2013 Jul

- CTA with fluoroscopy image fusion guidance in endovascular complex aortic aneurysm repair. **Sailer** AM Eur J Vasc Endovasc Surg. 2014 Apr

- Impact of hybrid rooms with image fusion on radiation exposure during endovascular aortic repair. Hertault A, Eur J Vasc Endovasc Surg. 2014 Oct

- Evaluation of visceral artery displacement by endograft delivery system insertion. Maurel B, J Endovasc Ther. 2014


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Conclusion

Old technology

New technology