

**PERCORSO
DIAGNOSTICO TERAPEUTICO
DELLE LESIONI SURRENALICHE
NELLA PROVINCIA DI FERRARA**

Sabato 3 dicembre 2022
Aula Magna Nuovo Arcispedale S. Anna
Cona, Ferrara

Il sampling delle vene surrenaliche – *R. Galeotti*

Dipartimento di Radiologia / Arcispedale S. Anna di Ferrara
Unità Operativa Semplice di Radiologia Vascolare ed Interventistica

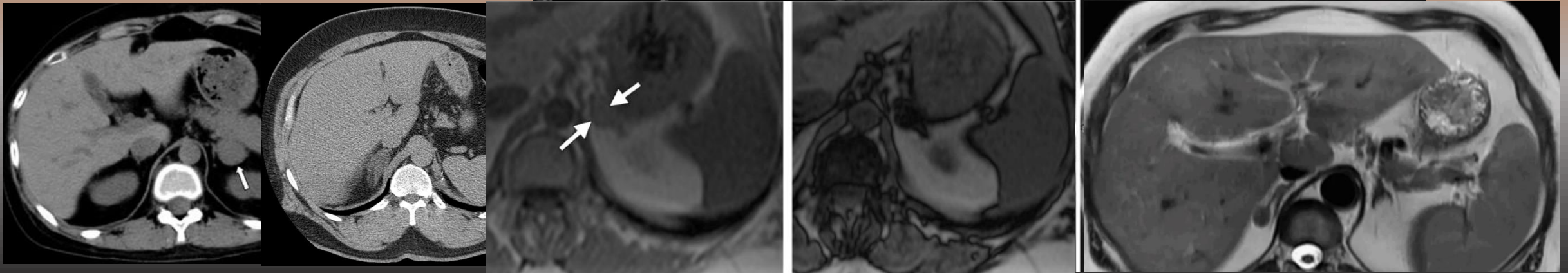
Adrenal Vein Sampling: How I Do It

A J Intervent Radiol 2019;3:44-9.

Adrenal vein sampling (AVS) is **one of the oldest** procedures still performed by interventional radiologists (IRs).

The technique was first reported in the **mid-1960s** as a means to **identify the site(s) of hormone-producing adrenal** or extra-adrenal tumors causing hypertension

The procedure **gained popularity over the following two decades** but then **lost favor in the 1990s** as cross-sectional imaging techniques such as computed tomography (CT) and magnetic resonance (MR) became **widely used** and refined.



However, the **significant limitations of CT and MR** in determining the sources of excess hormone production **are now well recognized** and have caused a **resurgence of interest in AVS**.

ADRENAL VENOUS SAMPLING: THE GOLD-STANDARD FOR SURGICAL INDICATION IN PRIMARY ALDOSTERONISM

N. Martell-Claros¹, M. Losada-Zafrilla¹, M. Abad-Cardiel¹, J.A. García-Donaire¹, B. Alvarez-Alvarez². ¹*U.Hipertension, S. Medicina Interna, Facultad De Medicina. UCM, Insti. Investigación Sanitaria, H Clinico San Carlos, Madrid, SPAIN,* ²*Centro Salud Andres Mellado, Madrid, SPAIN*

Journal of Hypertension Vol 36, e-Supplement 1, June 2018

Adrenal Vein Sampling Is the Preferred Method to Select Patients With Primary Aldosteronism for Adrenalectomy

Jaap Deinum, Aleksander Prejbisz, Jacques W.M. Lenders, Gert Jan van der Wilt
Hypertension. 2018;71:10-14.

Feasibility and effectiveness of a single-catheter approach for adrenal vein sampling in patients with primary aldosteronism

BMC Endocrine Disorders (2021) 21:22

Jindong Wan^{1,2}, Fei Ran^{1,2}, Siwei Xia^{1,2}, Jixin Hou^{1,2}, Dan Wang^{1,2}, Sen Liu^{1,2}, Yi Yang^{1,2}, Peng Zhou^{1,2}

Adrenal vein sampling in the diagnosis of aldosteronism

Journal of Vascular Diagnostics 2015:3 17–23

Amy R Deipolyi¹
Rahmi Oklu²

Adrenal Venous Sampling for Subtype Diagnosis of Primary Hyperaldosteronism

Mitsuhide Naruse^{1,2}, Akiyo Tanabe³, Koichi Yamamoto⁴, Hiromi Rakugi⁴, Mitsuhiro Kometani⁵, Takashi Yoneda⁵, Hiroki Kobayashi⁶, Masanori Abe⁶, Youichi Ohno⁷, Nobuya Inagaki⁷, Shoichiro Izawa⁸, Masakatsu Sone⁹

Endocrinol Metab 2021;36:965-973

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Cross sectional imaging (CT or magnetic resonance imaging-MRI) is insensitive in detecting sub-centimeter adrenal adenomas, which make up the majority of APAs. Additionally, both CT and MRI are insensitive to detect pathologically proven unilateral hyperplasia,

In patients with laboratory-confirmed PA , **cross-sectional imaging** can identify large adrenal masses concerning for malignancy, it **does not reliably distinguish unilateral from bilateral disease**, with nearly 40%–50% of patients misdiagnosed on CT or magnetic resonance imaging (MRI).

Sensitivity and specificity of CT and MRI have been reported to be **56%** and **57%**, and **60%** and **67%**, respectively. The low diagnostic yield of cross-sectional imaging is due to the **high incidence of incidental non-functioning adrenal lesions** and the presence of **microscopic nodules below the resolution** of CT or MRI.

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Adrenal Venous Sampling for Subtype Diagnosis of Primary Hyperaldosteronism

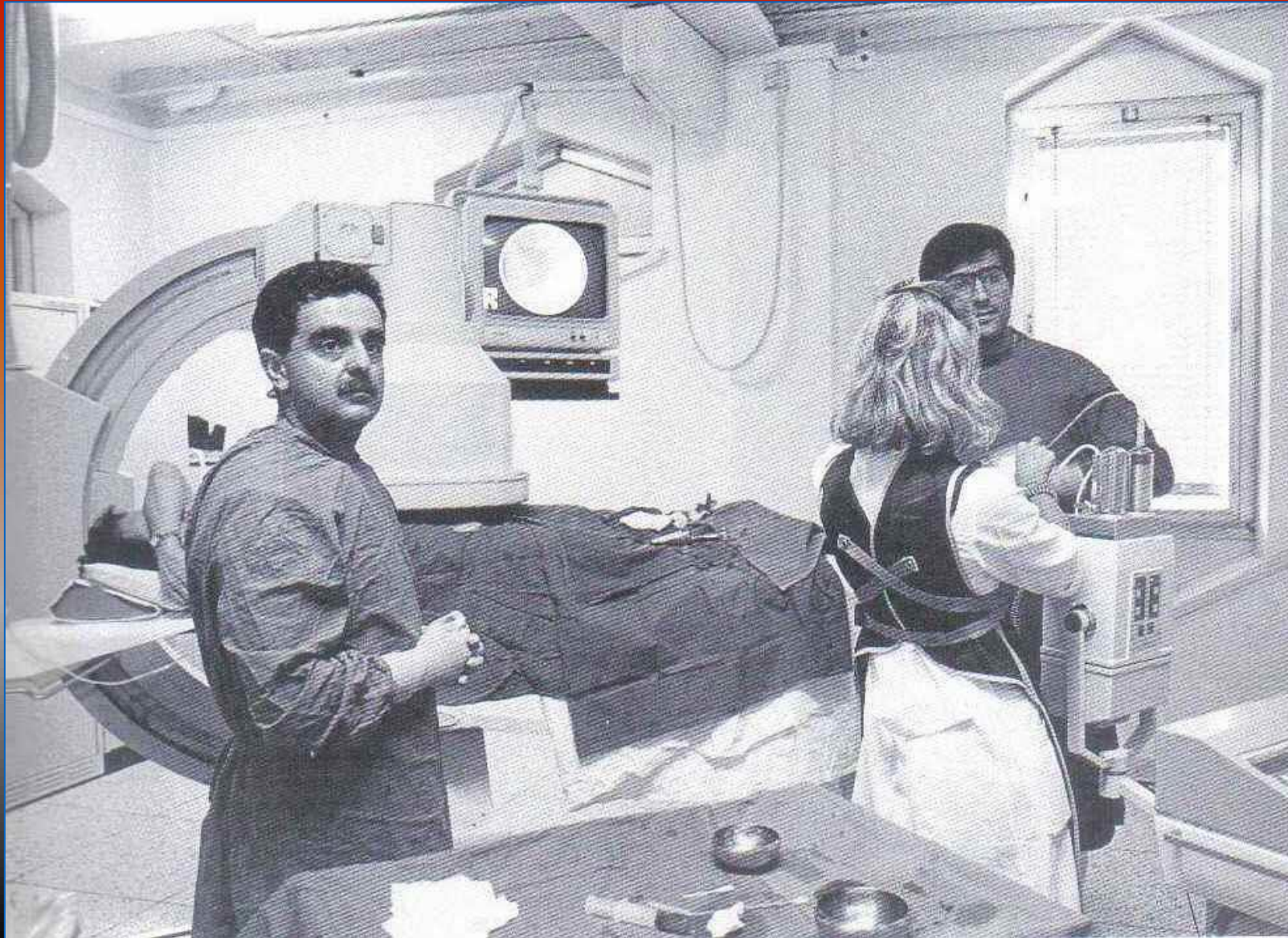
Mitsuhide Naruse^{1,2}, Akiyo Tanabe³, Koichi Yamamoto⁴, Hiromi Rakugi⁴, Mitsuhiro Kometani⁵, Takashi Yoneda⁶, Hiroki Kobayashi⁶, Masanori Abe⁶, Youichi Ohno⁷, Nobuya Inagaki⁷, Shoichiro Izawa⁸, Masakatsu Sone⁹

Adrenal vein sampling (AVS) is an **uncommonly performed** interventional procedure. However, it is **essential** in the management of patients with **primary aldosteronism**

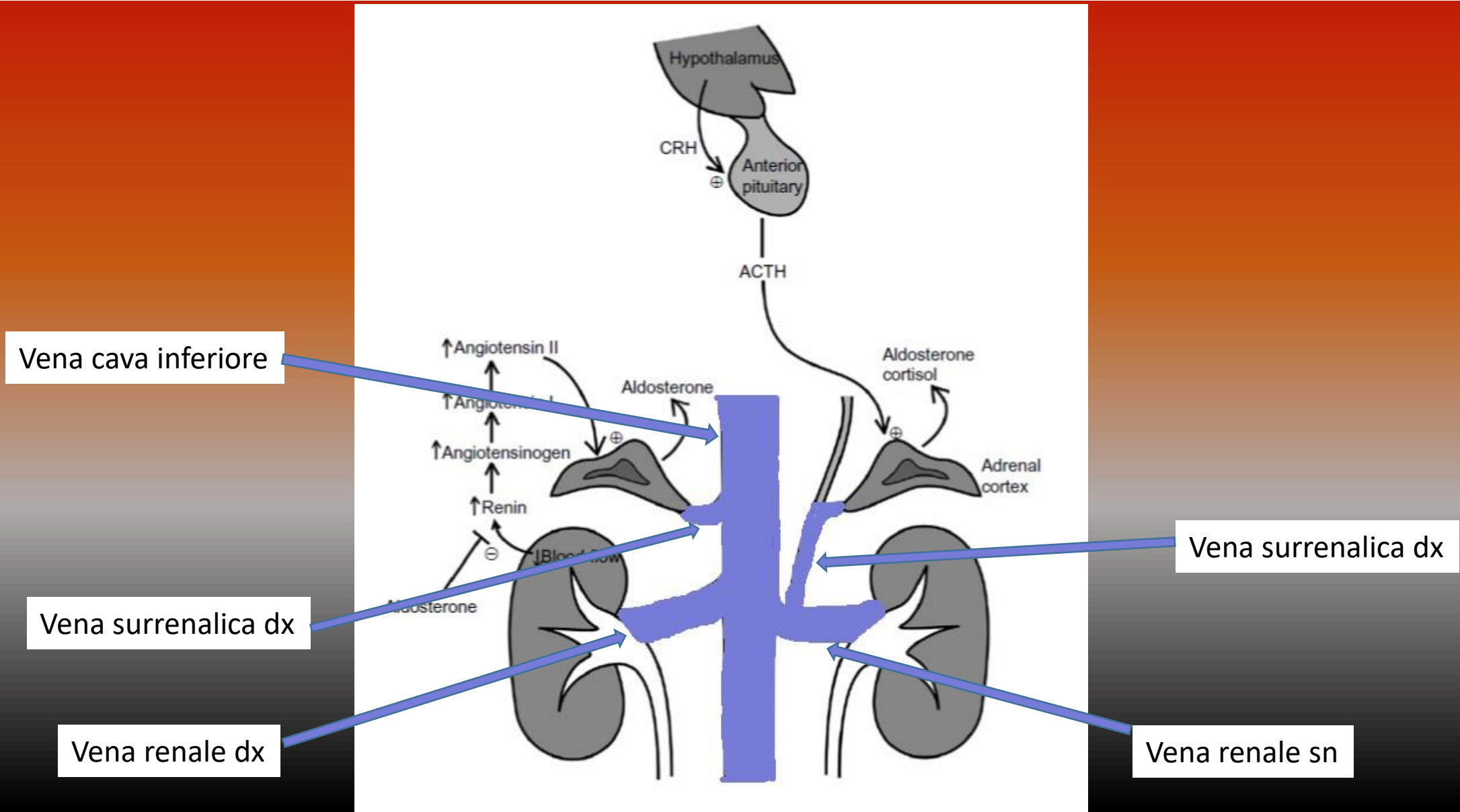
Adrenal vein sampling (AVS) is the **gold standard** test to localize sources of **excess aldosterone**

Adrenal venous sampling (AVS) is the **key procedure for lateralization** of primary hyperaldosteronism (PA) before surgery

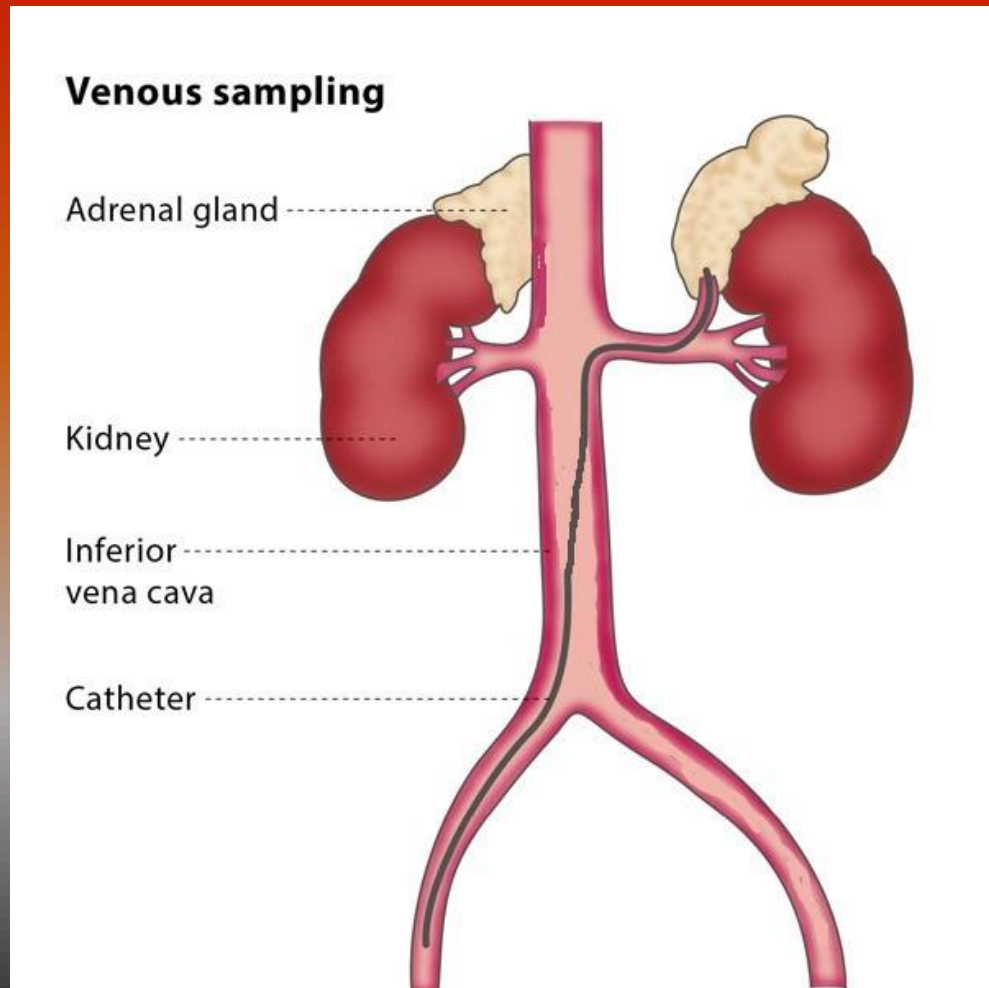
Adrenal vein sampling (AVS) is **one of the oldest** procedures still performed by interventional radiologists (IRs).



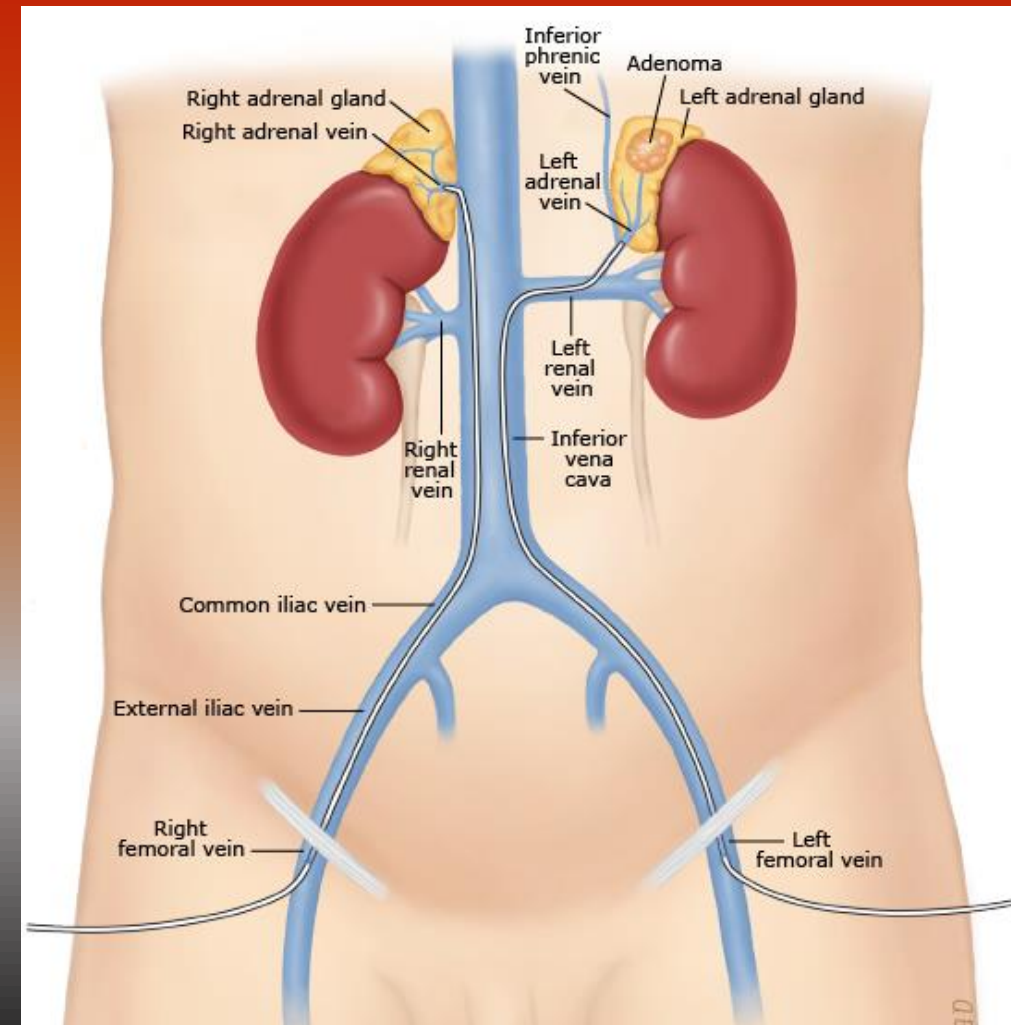
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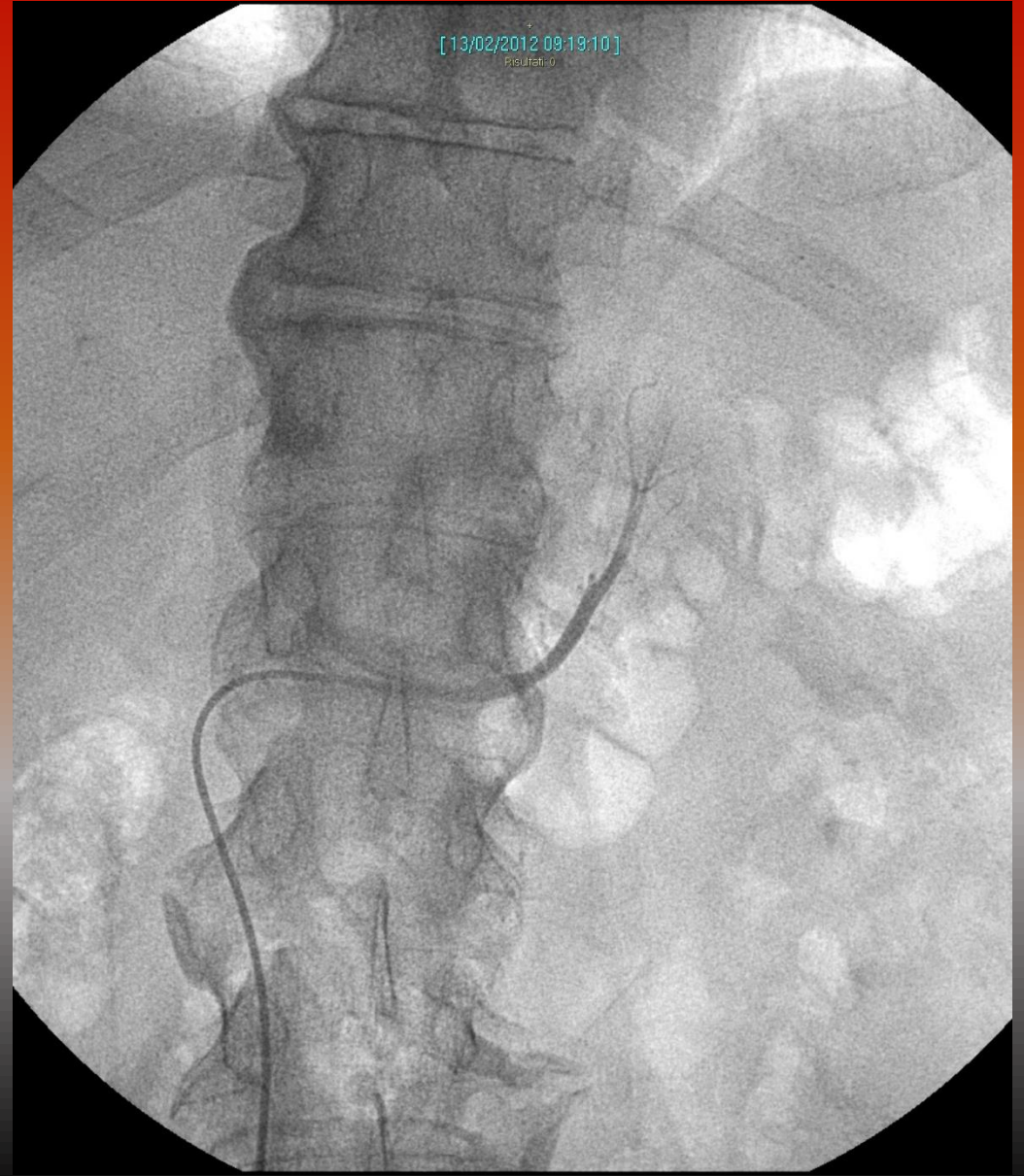
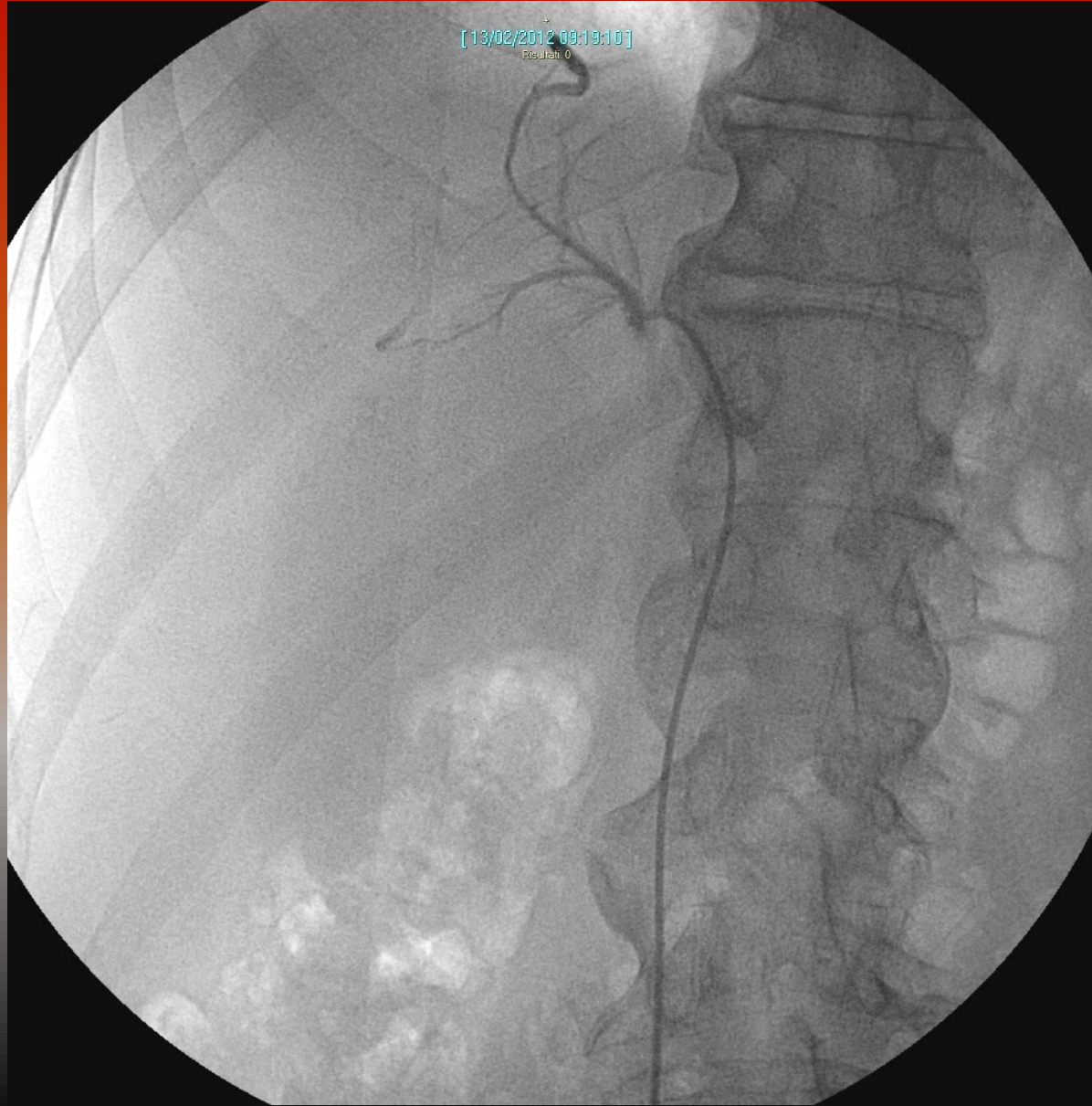


Tecnica sequenziale



Tecnica simultanea

Il sampling delle vene surrenaliche – R. Galeotti




Feasibility and effectiveness of a single-catheter approach for adrenal vein sampling in patients with primary aldosteronism

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BMC Endocrine Disorders (2021) 21:22

Catheterization of the **right adrenal vein** is particularly **challenging** because it is a relatively **small sized** vein with anatomical **variations**. Therefore, **localizing the right adrenal vein** during AVS is **critical for technical success**

Adrenal vein sampling: technique and protocol, a systematic review

Keith B. Quencer 

CVIR Endovascular (2021) 4:38

Right adrenal vein cannulation is **the most difficult part of AVS**; failure to cannulate the right adrenal vein is the most **common cause of an unsuccessful procedure**

EXPERT
REVIEWS

Improving adrenal venous sampling in primary aldosteronism

Evelyn Fischer¹,
Christoph Degenhart²
and Martin Reincke*¹

Expert Rev. Endocrinol. Metab. 7(5), 531–540 (2012)

While the **catheterization** of the **left adrenal vein** can be **easily** performed in almost all cases, the catheterization of the **right adrenal vein** is substantially **more difficult** for a number of reasons

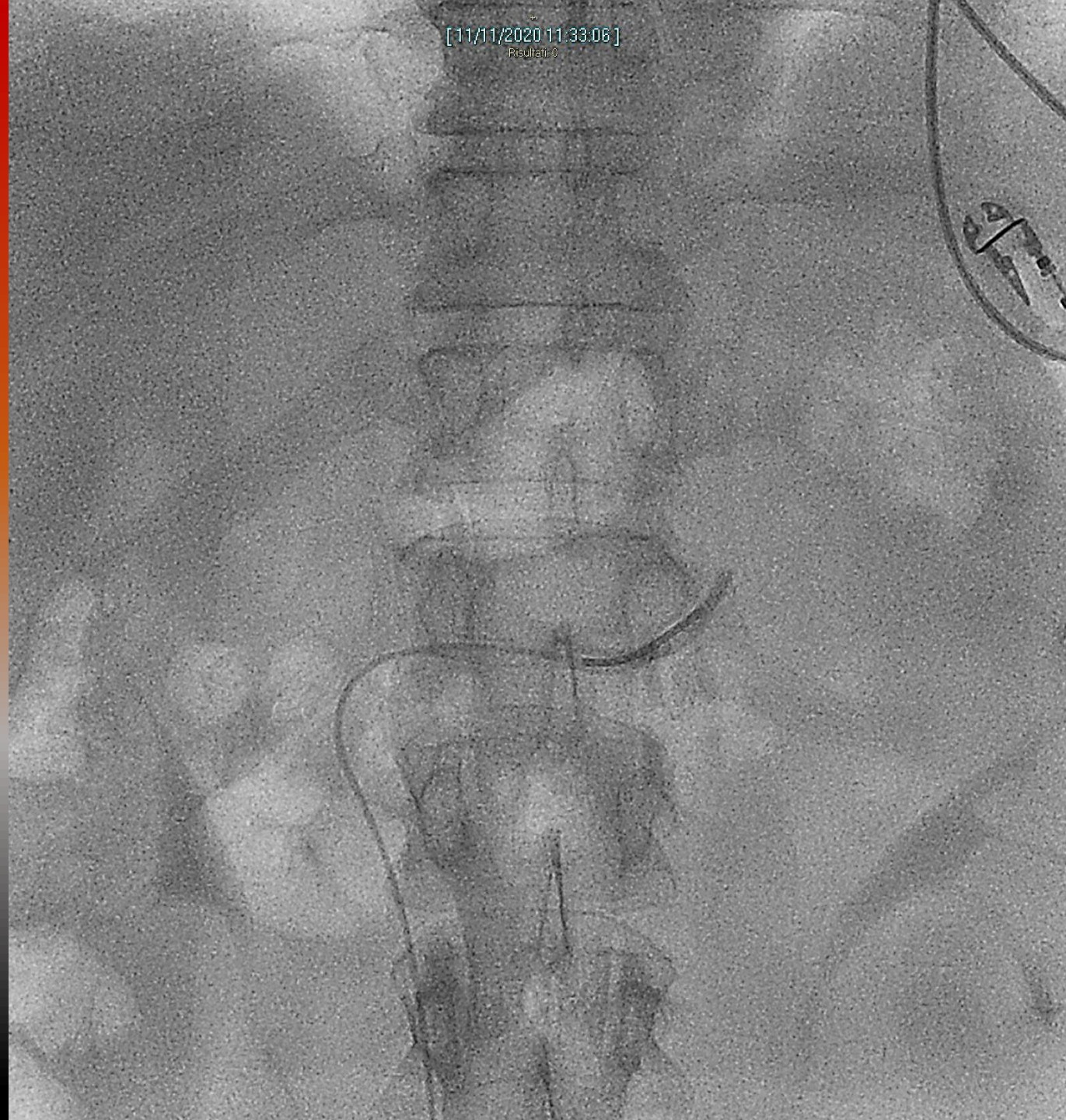
The **right adrenal vein** is very **short** and entering the IVC in **caudocranial direction**. Thus it may cause **difficulties to stabilize** the catheter in the small vein. Furthermore, there are some **other small veins** entering the IVC **nearby** the right adrenal vein, for example, **accessory hepatic veins**

Success rates for selective bilateral catheterization of the adrenal veins vary in a wide **range** between **31 and 98%**, depending on the center and the **expertise of the interventional radiologists**



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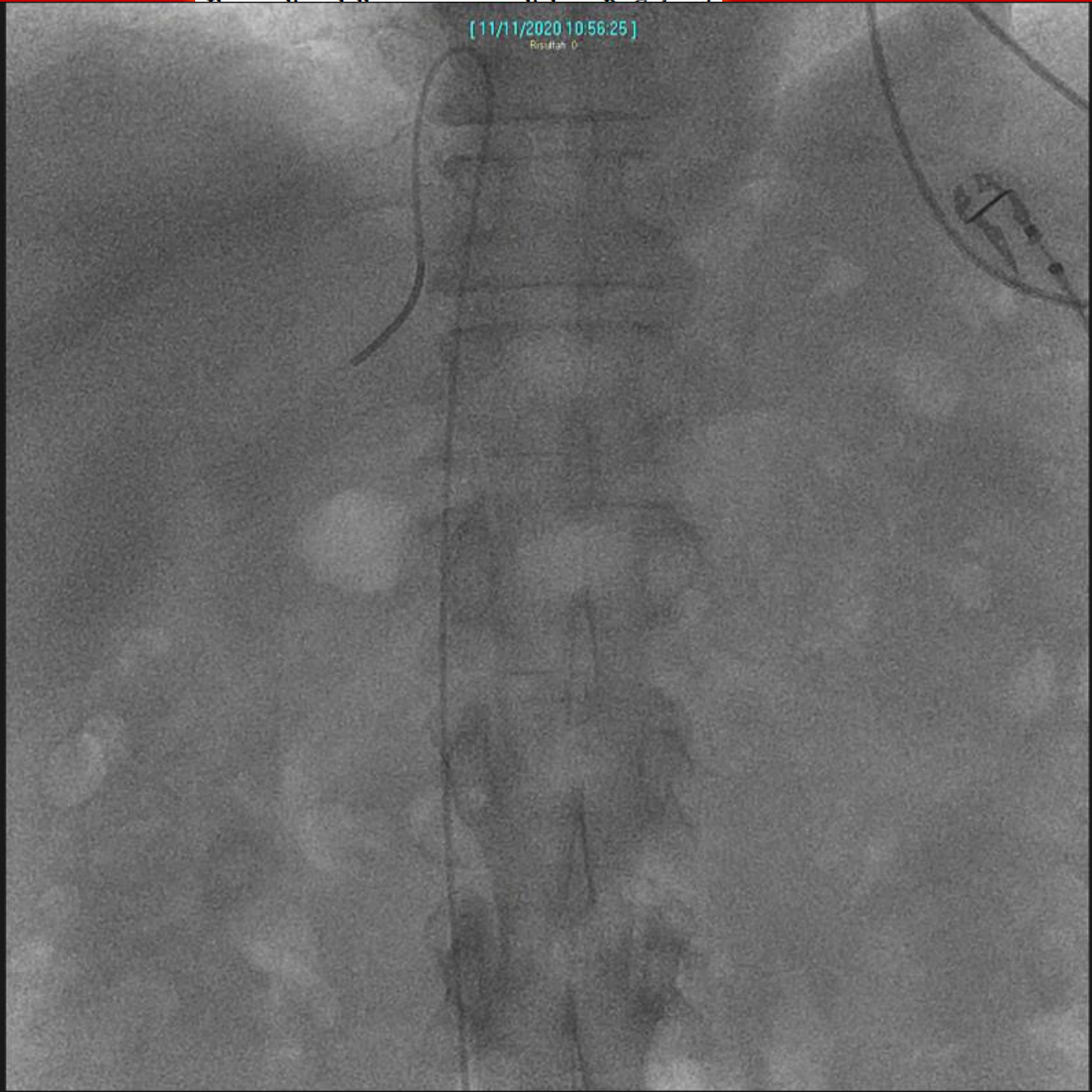
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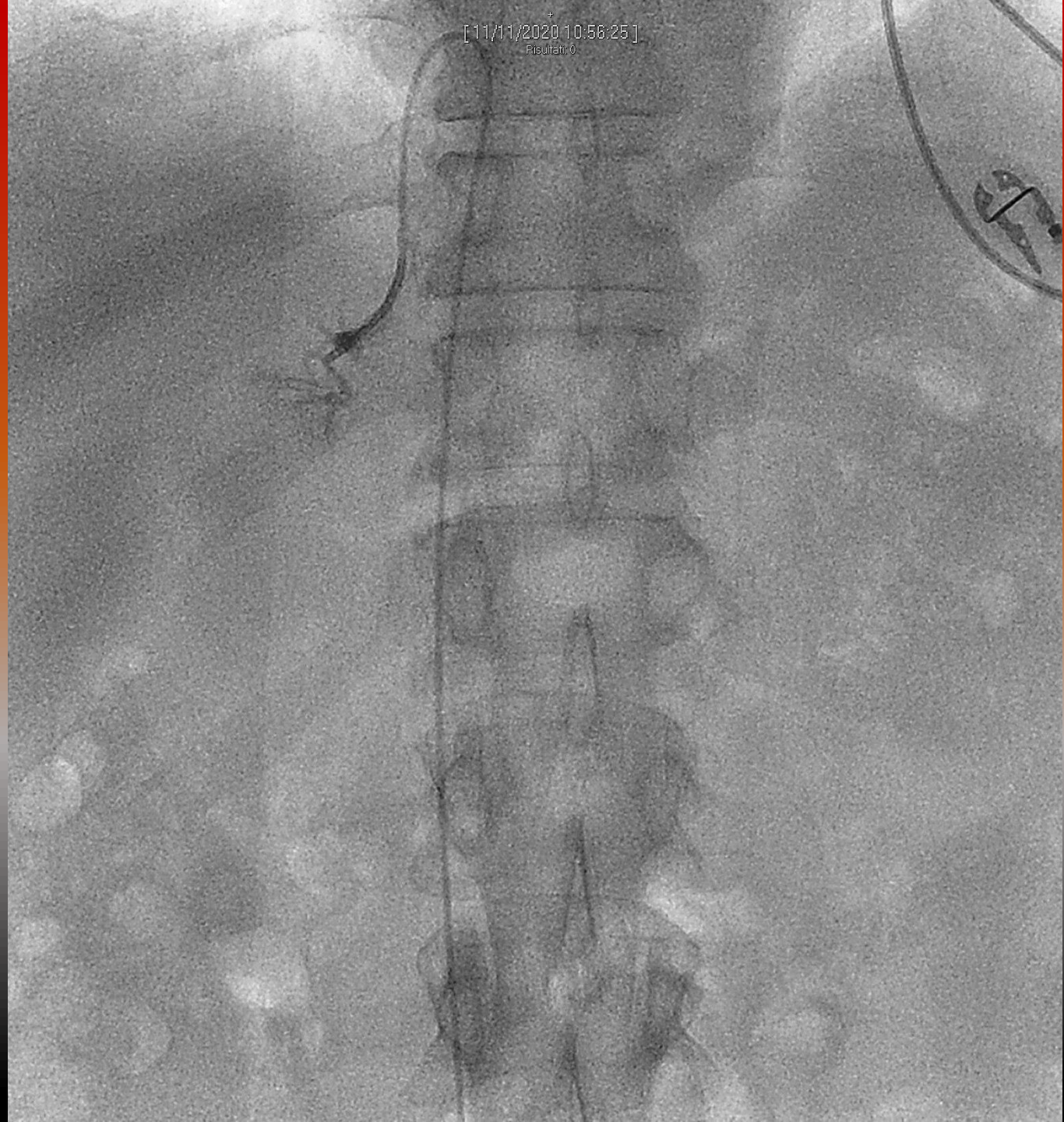
Il sampling delle vene surrenaliche – R. Galeotti

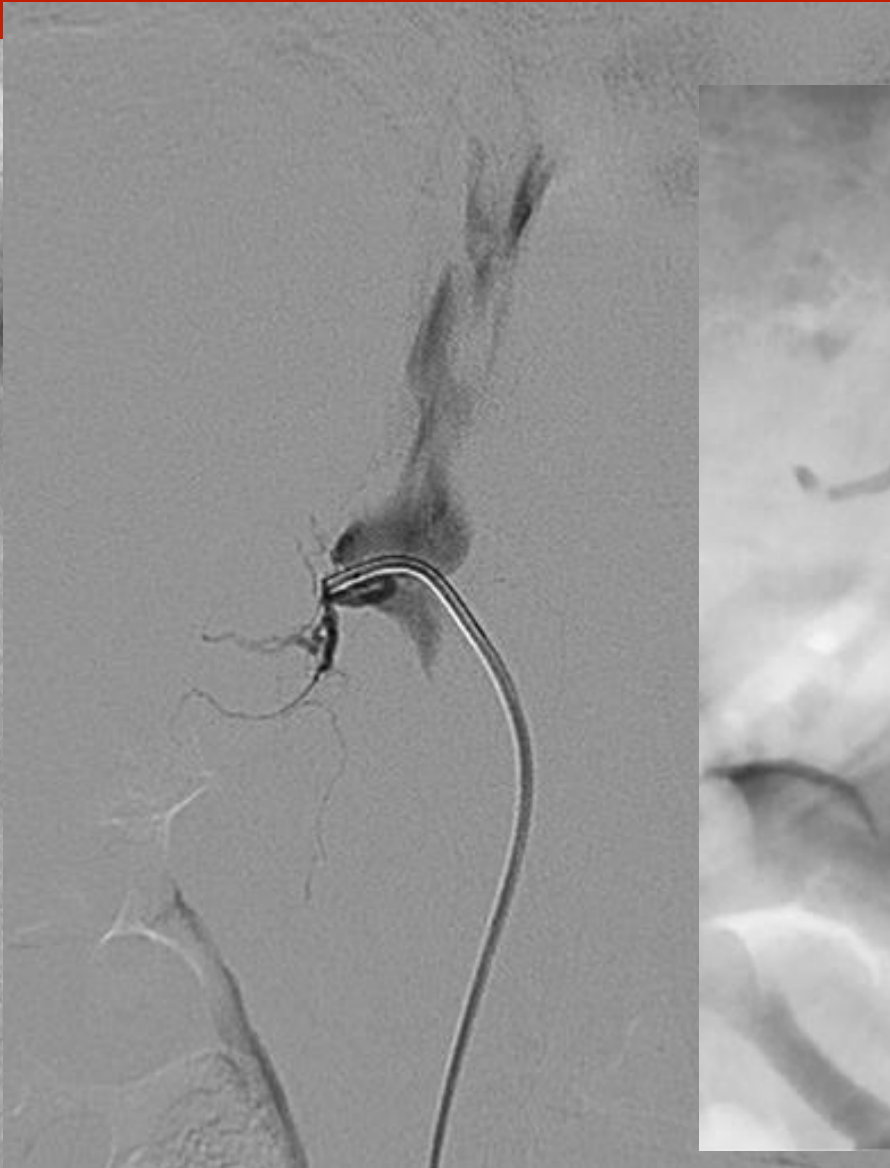


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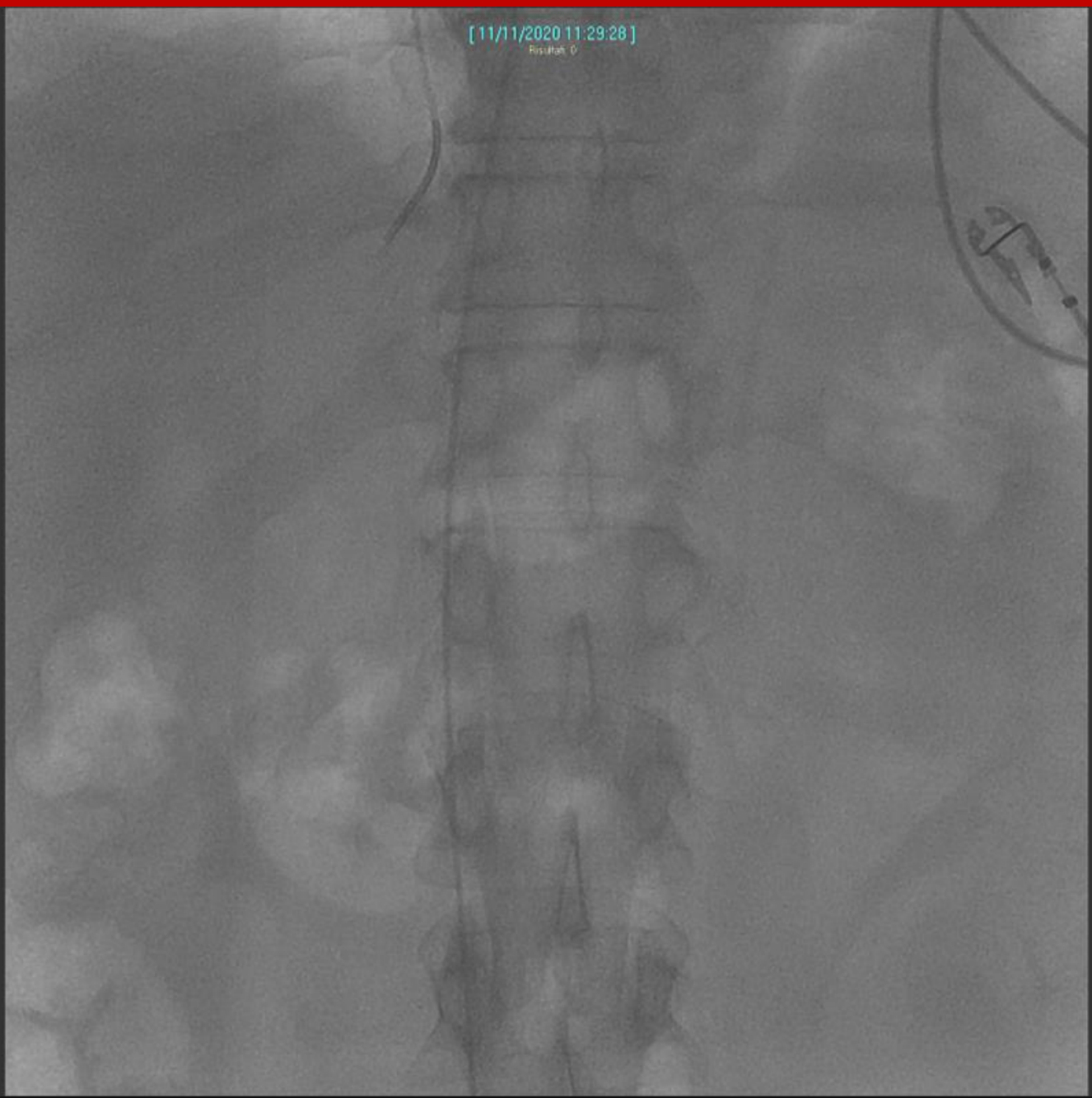


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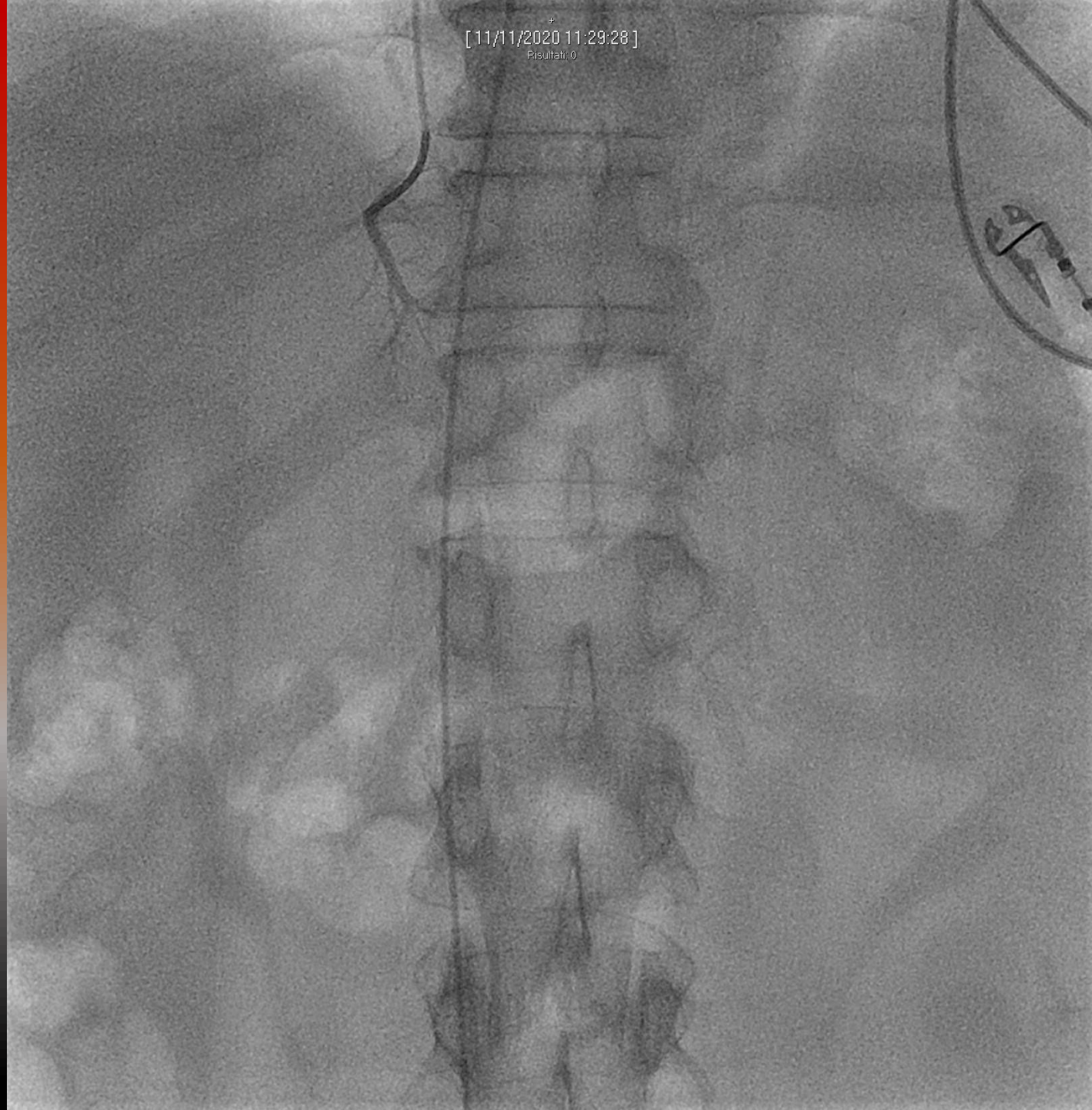




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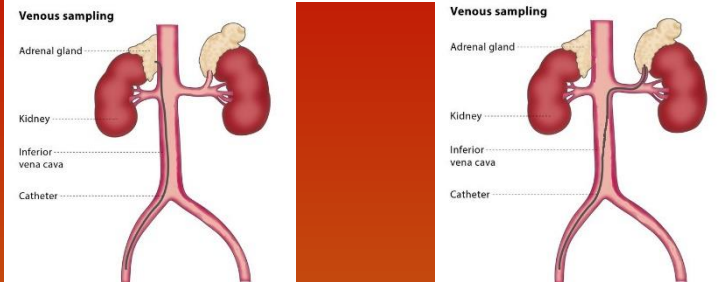
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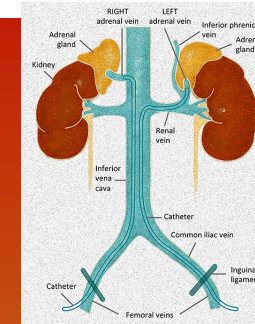
Il sampling delle vene surrenaliche – R. Galeotti



Tecnica sequenziale



Tecnica simultanea




Feasibility and effectiveness of a single-catheter approach for adrenal vein sampling in patients with primary aldosteronism

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Conclusions: The **single-catheter** approach is **feasible and effective** for AVS. Moreover, this approach required a learning curve for an inexperienced trainee

Adrenal vein sampling: technique and protocol, a systematic review

Keith B. Quencer 

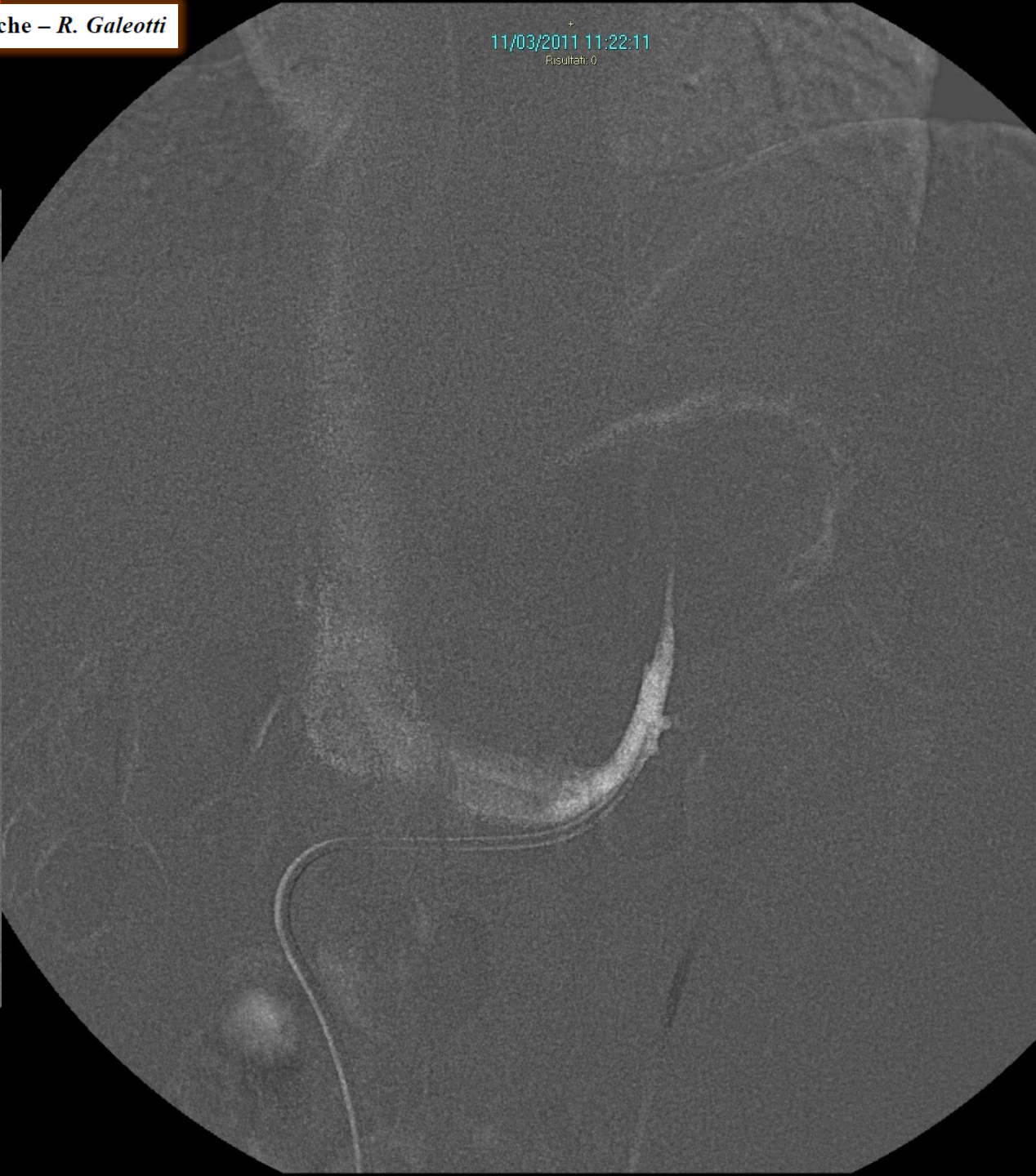
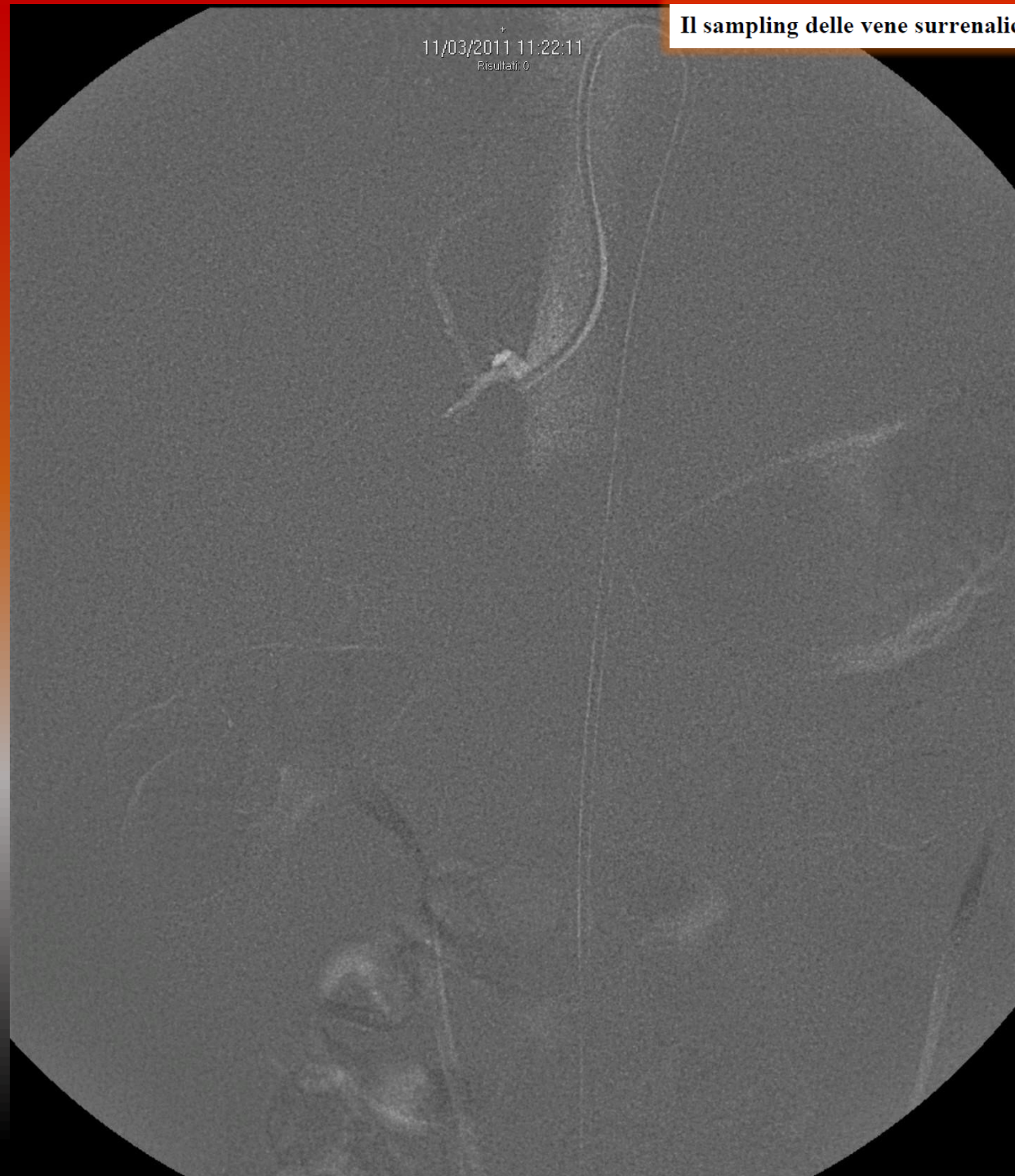
CVIR Endovascular (2021) 4:38

In **sequential AVS**, the **right adrenal vein** cannulation, which is more time consuming than the left, **should be done first** thereby **decreasing the time gap** between samplings.

11/03/2011 11:22:11
Risultati: 0

Il sampling delle vene surrenaliche – R. Galeotti

11/03/2011 11:22:11
Risultati: 0



Adrenal venous sampling: the learning curve of a single interventionalist with 282 consecutive procedures


Hugo Jakobsson 
Katerina Farmaki 
Augustinas Sakinis 
Olof Ehn 
Gudmundur Johannsson 
Oskar Ragnarsson 

Diagn Interv Radiol 2018; 24:89–93

Adrenal venous sampling (AVS), the **gold standard for assessing laterality of primary aldosteronism**, is a **technically complicated** procedure with **success rates ranging between 30% and 96%**.

Satisfactory AVS success rate was achieved **after** approximately **36 procedures** and satisfactory success rate was maintained by performing approximately **27 procedures annually**.
AVS should be limited to few operators that perform sufficiently large number of procedures to achieve, and maintain, satisfactory AVS success rate

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Adrenal vein sampling **may be non-diagnostic in a significant proportion of cases**. One study that highlighted this difficulty was the German Conn registry :**Diagnostic Adequacy was achieved in only 41.1%** of procedures.

But, **with proper training, knowledge and experience it can be performed successfully**.

AVS is typically done at **major referral centers** and has a **greater success in the hands of interventionalists experienced** in this procedure.

The **learning curve** is estimated to be about **20–30 cases** with maintenance of proficiency of about **15 annual cases**

Adrenal Vein Sampling to Distinguish Between Unilateral and Bilateral Primary Hyperaldosteronism: To ACTH Stimulate or Not?

Tae-Yon Sung^{1,2,*}, Wilson Mawutor Alobuia² , Monica Varun Tyagi², Chandrayee Ghosh² and Electron Kebebew²

J. Clin. Med. 2020, 9, 1447;

AVS can be performed **with or without adrenocorticotrophic hormone (ACTH) stimulation**.

Many referral centers around the world perform ACTH **stimulation to avoid the problem of aldosterone and cortisol pulsatile variation** and increase the gradient as compared to non-stimulation

However, there are **no specific guideline** recommendations as to whether ACTH stimulation is necessary for AVS or improves the ability to distinguish between unilateral and bilateral PA

Adrenal Venous Sampling With or Without Adrenocorticotrophic Hormone Stimulation: A Meta-Analysis

Irakoze Laurent,^{1,2} Manirakiza Astère,³ Fengfan Zheng,¹ Xiangjun Chen,¹ Jun Yang,⁴ Qingfeng Cheng,¹ and Qifu Li¹

J Clin Endocrinol Metab, April 2019, 104(4):1060–1068

Review Article

Karim Valji

University of Washington
Medical Center, Seattle,
Washington, USA

Adrenal Vein Sampling: How I Do It

A J Intervent Radiol 2019;3:44-9.

Confirmation of Proper Sampling

Catheterization is **rarely a problem with the left** adrenal vein.

When venography of the putative **right adrenal vein is atypical** or possibly represents hepatic vein, some operators will perform **C arm CT venography** to confirm the location.

However, the **most accurate** method to ensure correct sampling is **rapid cortisol analysis** of specimens before ending the procedure. Most laboratories can perform this analysis within 45–60 min.

As **cortisol is produced solely by the adrenal glands**, cortisol **gradient between the peripheral veins and “adrenal” vein** is used to confirm adequate adrenal vein cannulation.

There is a wide variety (≥ 1.1 to ≥ 5) of **Selectivity Indices** used to determine sampling adequacy .

Selectivity Indices > 2 and > 5 are generally used as cutoffs for adequacy with **unstimulated** and **stimulated** sampling, respectively

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Journal of Vascular Diagnostics 2015;3 17–23

Amy R Deipolyi¹

Rahmi Oklu²

AVS results interpretation


Once it has been proven that both left and right AVs have been adequately sampled, the next step is to **determine if results are lateralizing to one gland.**

The **aldosterone level (A)** in each sample is normalized to the **cortisol level (C)** : (A_{LAV}/C_{LAV} and A_{RAV}/C_{RAV}).

Then, **one side is divided by the other** to determine the **Lateralization Index (LI)** :

$LI \geq 4$ is compatible with a unilateral source of aldosterone

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CVIR Endovascular (2021) 4:38

Lateralization

Lateralization Indices (L.I.) of **> 2** for **unstimulated** and **> 4** for **stimulated** sampling are recommended by the Endocrine Society

Adrenal Vein Sampling: How I Do It

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Complications

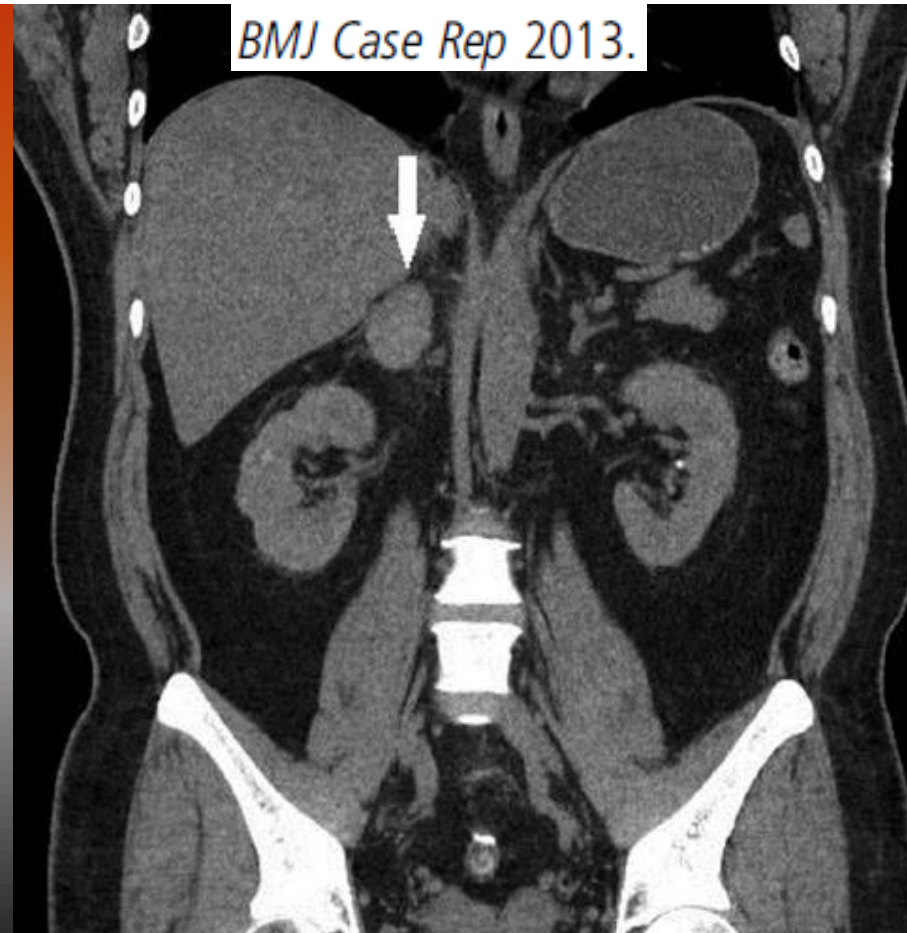
AVS is a remarkably **safe procedure**. Significant **adverse events** are **very uncommon**.

They include the usual **rare complications** associated with venography from the **femoral vein** (e.g., bleeding, thrombosis, contrast reaction, and contrast nephropathy).

The **specific complication** of this procedure is **injury to the** (usually **right**) **adrenal vein** from catheterization itself or more commonly over injection of contrast, leading to **vein rupture**, vein **thrombosis**, gland or **perigland hematoma**, or adrenal infarction. This complication occurs in **<1%** of cases in high volume centers.

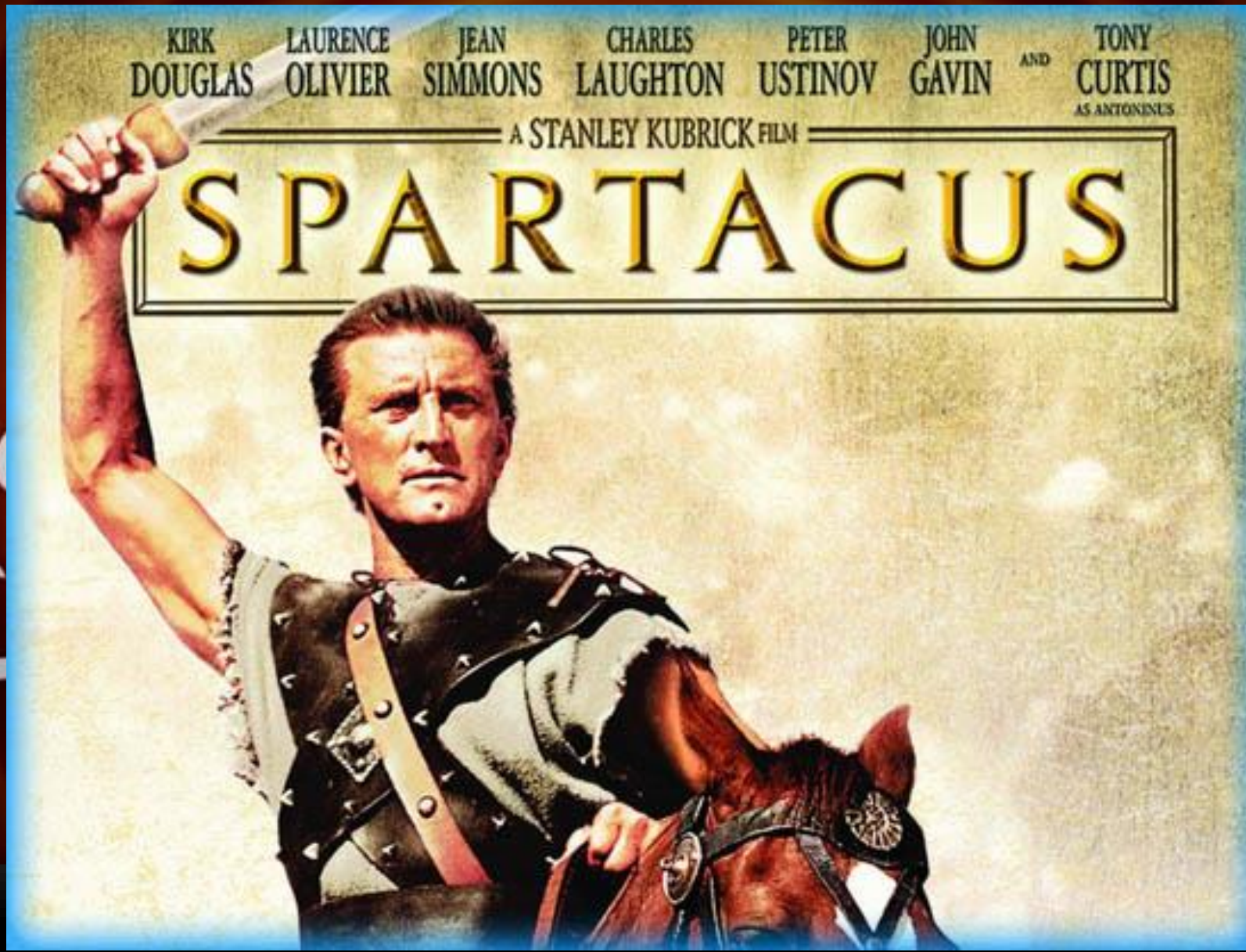
Adrenal haematoma as a complication of adrenal vein sampling

Mourad Hussein Senussi,¹ Nizar Hussein Senussi,² Ahmad Alwakkaf,¹
Shawn G Kwatra¹



The patient symptomatically improved with analgesics, intravenous fluids, and did not need any surgical intervention

However, the significant limitations of CT and MR in determining the sources of excess hormone production are now well recognized and have caused a resurgence of interest in AVS.



Il sampling delle vene surrenaliche – R. Galeotti

SPARTACUS

Dekkers T, Prejbisz A, Kool LJS, et al;

SPARTACUS Investigators.

Adrenal vein sampling versus CT scan to determine treatment in primary aldosteronism: an outcome-based randomised diagnostic trial.

Lancet Diabetes Endocrinol. 2016 ;4:739–746

SPARTACUS trial (S ubtyping P rimary A ldosteronism: a R andomized T rial Comparing A drenal Vein Sampling and C omp u ted Tomography S can), in 192 patients with PA

We **compared** outcomes in **patients with PA** who had been **managed based** on either a **CT scan** result or an **AVS** result. Management consisted of **adrenalectomy**, if an **APA** was suspected, or **medical therapy** (mineralocorticoid receptor antagonist), if **bilateral hyperplasia** was found

After 1 year follow-up, **no significant differences** in any of the patient-important outcomes, such as **antihypertensive medication use** and **quality of life**, were observed

AVS causes **additional radiation exposure**, probably even more so when performed by less-experienced radiologists. This aspect **reduces the attractiveness** of AVS considerably but is largely **ignored by the guideline**

KIRK DOUGLAS LAURENCE OLIVIER JEAN SIMMONS CHARLES LAUGHTON PETER USTINOV JOHN GAVIN AND TONY CURTIS
AND ANTHONY QUINN

A STANLEY KUBRICK FILM

SPARTACUS



Radiation dose reduction

SERVIZIO SANITARIO REGIONALE EMILIA-ROMAGNA Azienda Ospedaliero - Universitaria di Ferrara	Servizio Comune INGEGNERIA CLINICA	Modulo Interaziendale COLL1 Pagina 1 di 1
SERVIZIO SANITARIO REGIONALE EMILIA-ROMAGNA Azienda Unità Sanitaria Locale di Ferrara		Rev. 4

Ferrara, li 22/12/2021
AZIENDA OSPEDALIERO UNIVERSITARIA DI FERRARA

682 - RX VASC.RADIOL.UNIV.

Servizio Inventario Beni Mobili

Oggetto: Comunicazione esito collaudo.
Si comunica con la presente che l'apparecchiatura:

DATI ANAGRAFICI

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N° Cespite SAP: 3001664-8	Rivenditore: PHILIPS S.P.A.
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ha superato positivamente il collaudo in data 22/12/2021, e *si esprime parere favorevole all'accettazione.*

The most **challenging** RAV ostium from the

vein (RAV). Identifying the

Our study demonstrates that the **AlluraClarity technology** upgrade enables a radiation dose reduction up to one **third** in patients during AVS compared to the precursor technology Allura Xper **without compromising image quality.**

Review Article

Karim Valji

*University of Washington
Medical Center, Seattle,
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Adrenal Vein Sampling: How I Do It

A J Intervent Radiol 2019;3:44-9.

It is true that the recent multicenter, randomized **SPARTACUS trial did not show a significant difference** in intensity of **antihypertensive drugs** given or **clinical benefit** from management based on **AVS compared with CT imaging** alone.

However, **there has been substantial criticism of that study**, and most **authorities** in the field continue to **insist on AVS** prior to operation **for PA**

Response to Adrenal Vein Sampling Is the Preferred Method to Select Patients With Primary Aldosteronism for Adrenalectomy: Con Side of the Argument

Gian Paolo Rossi, John W. Funder

Hypertension. 2018;71

The **evidence** from the **SPARTACUS trial** (Subtyping Primary Aldosteronism: a Randomized Trial Comparing Adrenal Vein Sampling and Computed Tomography Scan) has been **dissected at length**, in the pro case and elsewhere. The **authors limit** their caveats to plus or minus cosyntropin, **omitting key issues**, such as patient inclusion (sex and age), **imaging discrepancies**, sequential sampling AVS recently shown to be suboptimal, **unusual therapy/end points**, plus **statistical inadequacy**— **all of which disqualify the trial**



To paraphrase **Winston Churchill** on democracy, *AVS is similarly far from perfect—but until (and unless) something better comes along, it is the best we have got.*

Adrenal vein sampling in the diagnosis
of aldosteronism

Journal of Vascular Diagnostics 2015;3 17–23

Amy R Deipolyi¹

Rahmi Oklu²

Conclusion and future perspectives

Assuming a population of **320 million US citizens**, with more than **25%** of people affected by **hypertension** and **15%** of these cases due to **PA**, one may estimate **12 million people who may have an indication for AVS**.

As **40%** of these would be expected to be **due to aldosterone-producing adenomas** and the vast majority of patients are cured after **adrenalectomy**, we can estimate that over **4 million patients** could be **diagnosed with AVS and surgically cured**.

Close collaboration with endocrinologists and surgeons is warranted to allow **interventional radiologists** to help in treating these patients.

Il sampling delle vene surrenaliche – *R. Galeotti*



Università
degli Studi
di Ferrara

GRAZIE PER L'ATTENZIONE

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*Dipartimento di Radiologia / Arcispedale S. Anna di Ferrara
Unità Operativa Semplice di Radiologia Vascolare ed Interventistica*