

# Demystifying Endovascular Treatment of Abdominal Aortic Aneurysms: A Study by Ct Angiography at a Tertiary Hospital

Md. Khizer Razak, Surbhi Gupta, Meena GL\*

Department of Radiodiagnosis, Sardar Patel Medical College, Bikaner, Rajasthan, India

## Abstract

**Aims & Objectives:** The aim of this study is to compare the results of Doppler ultrasound with enhancer (EDP) versus CT angiography in the follow-up of patients with AAA(Abdominal-aortic-aneurysms) treated with EVAR(endovascular treatment), compare our results with the published literature and be able to validate the EDP in our hospital for the follow-up of AAAs treated by EVAR.

**Material & Methods:** Of all patients with AAA treated by EVAR in our P.B.M hospital and to whom controls are being performed, 22 patients were randomly selected. The informed consent of the patients was obtained both for the performance of the control CT angiography and for the realization of the EDP. All of them underwent first a CT angiography and then the EDP. Two radiologists, one with 21 years of experience in EDP and the other radiologist with 3 years of experience in angio-CT, independently analyzed the results of the tests without knowing the results of the other test.

**Results:** The mean diameter of the residual aneurysmal sac measured by EDP was  $64.49 \pm 15.12$  mm (41.5-104) with a median of 63 mm and measured by angio-CT showed an average diameter of  $59.41 \pm 17.54$  mm (30-108) with a median of 59 mm. Angio-CT identified a leak in 13.63% of the cases (n=3). The EDP demonstrated leakage in 31.82% of the cases (n=7), all type II; in 85.72% of cases (n=6) they corresponded to hyperdynamic type II leaks (before 100 seconds) and 14.28% of cases (n=1) corresponded to hypodynamic type II leaks (after 100 seconds). The values of sensitivity, specificity, positive and negative predictive value of the EDP were: sensitivity 100%, specificity 79%, positive predictive value 43% and negative predictive value 100%.

**Conclusion:** The EDP is a technique that does not irradiate, it can be used in patients in whom the use of iodinated contrast is contraindicated. It is more specific than angio-CT for detecting low-flow leaks, being able to consider it as the first modality of imaging in the follow-up of patients after EVAR. The EDP allows an economic saving since the angio-CT or angio-MR are more expensive than the realization of an EDP. Our results are in agreement with those published by other authors, but we need a wider series to give greater statistical strength to our results. There is a perfect correlation between the two techniques when assessing the diameter of the residual aneurysmal sac.

**Keywords:** Aneurysm; Aorta; Imaging; Angiography; Treatment

## Introduction

The endovascular treatment (EVAR) of abdominal aortic aneurysms (AAA) is an alternative to open surgery accepted in selected patients [1].

After performing an endovascular treatment (EVAR) of an abdominal aortic aneurysm (AAA), the patient should be monitored to assess various parameters such as permeability, mobilization and distortion of the prosthesis, control the diameter of the residual aneurysmal sac, detect infectious complications and identify the presence or absence of endoleaks, which correspond to an incomplete exclusion of the aneurysm with presence of blood flow outside the endoprosthesis but within the aneurysmal sac or adjacent vascular structures that have been treated with the endoprosthesis. The decrease in diameter of the residual aneurysmal sac, known as remodeling, indicates that the treatment has been effective; being an indicator of success of the EVAR (Figures 1 and 2). On the contrary, the presence of a leak or endotension represent a failure in the endovascular treatment of AAA since they imply that the aneurysm remains pressurized and therefore the risk of rupture of the aneurysm persists. The presence of endoleaks is the most frequent complication after EVAR, having described a frequency of 10-45% [1,2] of patients depending on the different imaging techniques used for follow-up [1].

Leaks are classified into 5 types:

a) Type I: for failure to seal the prosthesis in the proximal or distal anchor. This type of endoleaks, if detected at the time of implantation of the endoprosthesis, should be treated immediately since they will not resolve spontaneously and therefore imply that the aneurysm continues to be pressurized with the consequent risk of rupture. This type of leak can be treated by ATP or by prolonging the endoprosthesis, if the anatomical characteristics of the aneurysm allow it (Figures 3-8)

b) Type II: due to the existence of collateral circulation, usually from the inferior mesenteric artery or from the lumbar branches, which continue to pressurize the aneurysm. They can be classified as hyper or hypodynamic, as they appear before or after 100 seconds [3]. It is the most common type of leak, and tends to self-limiting in most cases, so it requires evolutionary control and in the case that the diameter of

\*Corresponding author: Meena GL, Senior professor & Head, Department of Radiodiagnosis, Sardar Patel Medical College, Bikaner, Rajasthan, India; Tel: +917014929344; E-mail: [meenabkn@yahoo.co.in](mailto:meenabkn@yahoo.co.in)

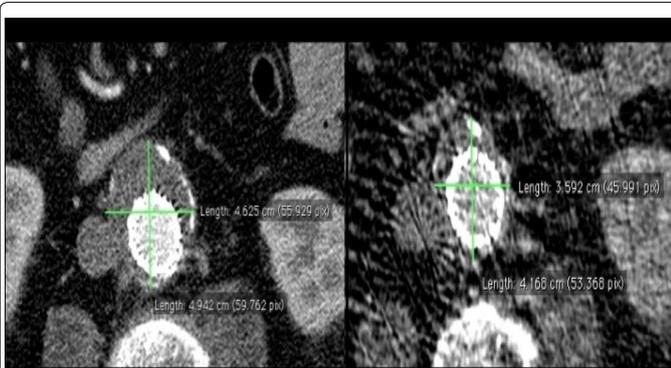
Received November 14, 2017; Accepted November 23, 2017; Published November 30, 2017

Citation: Razak K, Gupta S, Meena GL (2017) Demystifying Endovascular Treatment of Abdominal Aortic Aneurysms: A Study by Ct Angiography at a Tertiary Hospital. Angiol 5: 204. doi: [10.4172/2329-9495.1000204](https://doi.org/10.4172/2329-9495.1000204)

Copyright: © 2017 Razak K, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



**Figure 1:** Abdominal-pelvic CT angiography after administration of axial plane contrast. Example of aortic remodeling after EVAR. On the left, control at 6 months after treatment and on the right side of the control image at 18 months after treatment. Abdominal aortic endoprosthesis is observed. In (1) the remodeling of the residual aneurysmal sac can be seen visually. In (2) the remodeling of the residual aneurysmal sac with measurements is objectified.



**Figure 2:** Abdominal-pelvic angio-CT after administration of axial plane contrast. Example of aortic remodeling after EVAR. On the left, control at 6 months after treatment and on the right side of the control image at 18 months after treatment. Abdominal aortic endoprosthesis is observed. In (1) the remodeling of the residual aneurysmal sac can be seen visually. In (2) the remodeling of the residual aneurysmal sac with measurements is objectified.



**Figure 3:** Abdominal-pelvic angio-CT after administration of iv contrast in axial (3), Example of type I endoleak in the distal anchor of the branch or extension in the left common iliac. It was treated by prolonging the extension of the common iliac by placing a stent with a seal in the left external iliac and embolizing the left hypogastric artery with coils.

the aneurysm continues to increase it would require treatment (Figures 9-14).

c) Type III: they occur in the assembly between the different

components of the modular endoprosthesis. They are infrequent. When they are detected they should be treated immediately as type I (Figures 15-21).

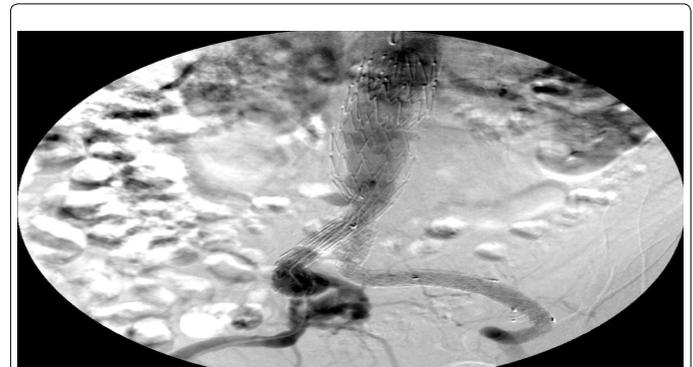
d) Type IV: they occur due to porosity or wear of the material of the endoprosthesis. They are very rare nowadays. Its presence would imply the need to implant a new prosthesis.



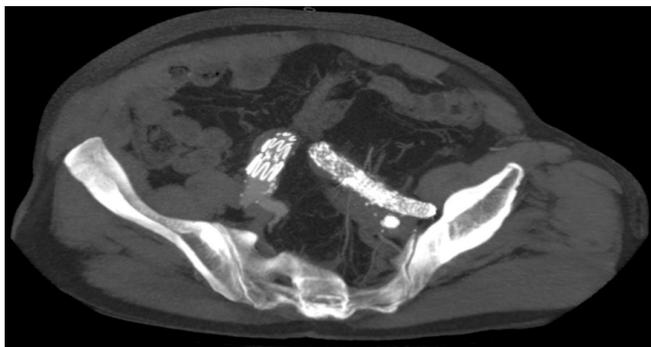
**Figure 4:** Abdominal-pelvic angio-CT after administration of iv contrast in CORONAL MIP, Example of type I endoleak in the distal anchor of the branch or extension in the left common iliac. It was treated by prolonging the extension of the common iliac by placing a stent with a seal in the left external iliac and embolizing the left hypogastric artery with coils.



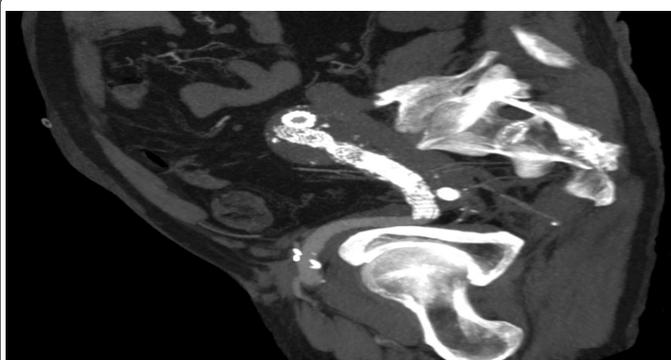
**Figure 5:** Abdominal-pelvic angio-CT after administration of iv contrast in sagittal MIP.



**Figure 6:** Abdominal-pelvic angio-CT after administration of iv contrast in axial, Example of type I endoleak in the distal anchor of the branch or extension in the left common iliac. It was treated by prolonging the extension of the common iliac by placing a stent with a seal in the left external iliac and embolizing the left hypogastric artery with coils.



**Figure 7:** Pelvic abdomino-CT angiography with contrast in axial plane (7) is shown, showing the prolongation of the endoprosthesis in the external iliac and embolization material in the left hypogastric artery.



**Figure 8:** Pelvic abdomino-CT angiography with contrast in sagittal MIP is shown, showing the prolongation of the endoprosthesis in the external iliac and embolization material in the left hypogastric artery.

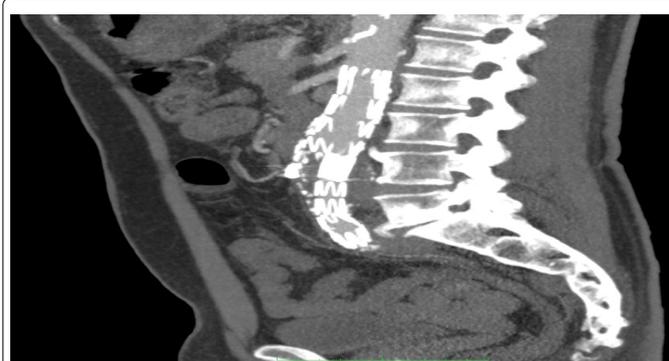


**Figure 9:** Abdominal-pelvic angio-CT after administration of IV contrast in axial plane. Example of type II endoleak, in this case from the inferior mesenteric artery, which persisted in the successive controls with an increase in the size of the residual aneurysmal sac, so it was decided to treat.

e) Type V or endotension: they are those in which there is no presence of contrast in the interior of the residual aneurysmal sac but there is a progressive growth of said sac in the successive controls. Many of these type V leaks are currently known to correspond to hypodynamic Type II leaks (Figures 22 and 23) [3].

Angio-CT is considered the gold standard technique for the follow-up of AAA treated with EVAR [4]. It is the technique that has been used and continues to be used for the follow-up of these patients, although some authors advocate the use of other techniques such as MRI, Doppler

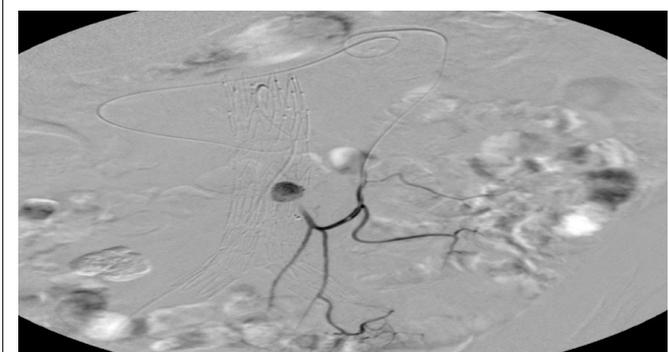
ultrasound and Doppler ultrasound with enhancer that in some articles have shown greater precision for the detection and characterization of endoleaks [1]. CT angiography is not free from risks: use of ionizing radiation; an abdominal CT is approximately 10 mSv, equivalent to 4.5 years of natural radiation; and in the follow-up of these patients by this imaging modality, a dose of approximately 145-205 mSv is calculated at 5 years, which increases the risk of cancer [4]. It also uses contrasts that are nephrotoxic and that some patients end up developing hypersensitivity-allergy to contrasts, having described a frequency of 0.2 to 23% with the use of non-ionic contrasts [5-7]. Adverse reactions



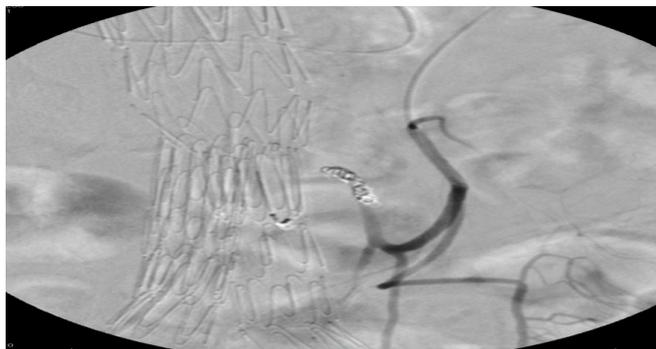
**Figure 10:** Abdominal-pelvic angio-CT after administration of IV contrast in sagittal MIP. Example of type II endoleak, in this case from the inferior mesenteric artery, which persisted in the successive controls with an increase in the size of the residual aneurysmal sac, so it was decided to treat.



**Figure 11:** Abdominal-pelvic angio-CT after administration of IV contrast in sagittal MIP.



**Figure 12:** Type II endoleak was confirmed by arteriography and was treated by embolization with coils placed at the origin of the inferior mesenteric artery.



**Figure 13:** Type II endoleak was confirmed by arteriography.



**Figure 16:** Abdominal-pelvic CT after administration of IV contrast in axial MIP.



**Figure 14:** In post-embolization control CT, permeable stent was observed without signs of leakage or complication. Note metallic artifact on the anterior side of the residual aneurysmal sac produced by the embolization material (coils).



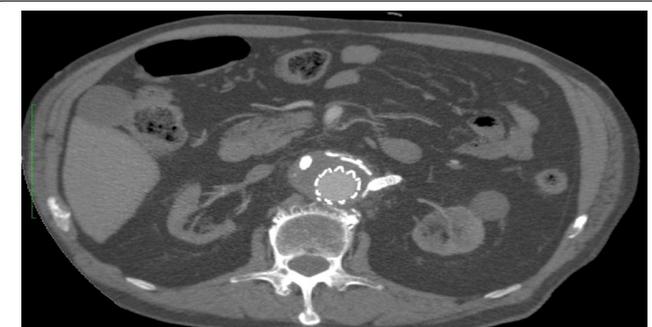
**Figure 17:** Abdominal-pelvic CT after administration of IV contrast in coronal scan.



**Figure 15:** Abdominal-pelvic CT after administration of IV contrast in axial plane. Example of type III endoleak due to disconnection of the branch for the right renal artery.

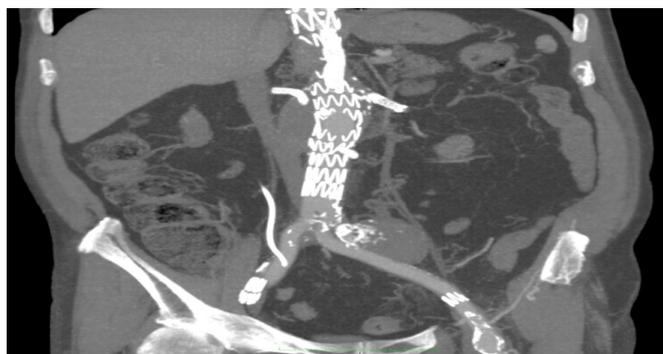


**Figure 18:** In abdomino-pelvic CT, axial plane - of control, type III endoleak was observed.

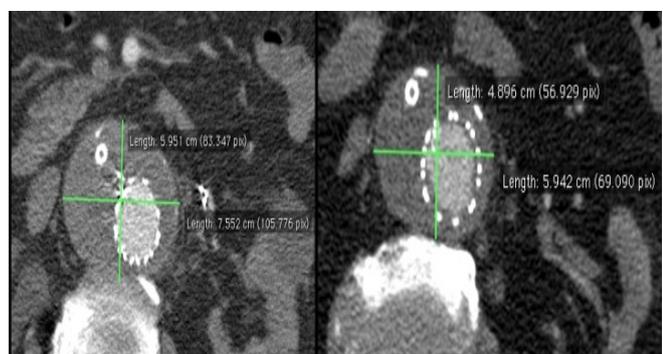


**Figure 19:** In abdomino-pelvic CT, axial plane MIP view - of control, type III endoleak was observed.

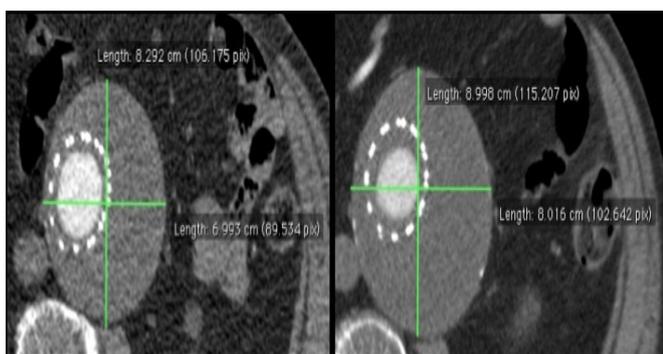
can be classified into mild, moderate and severe reactions that require hospitalization. They can also be classified as early or late, depending on whether they occur in the first 30-60 minutes after contrast injection and in delayed ones, if they occur between 30-60 minutes and 7 days after contrast injection [5,7]. They can present in the form of heat, nausea and vomiting, cardiac arrhythmia, hypertension, kidney failure, seizures, urticaria, nasal coryza, hypotension with tachycardia, bronchospasm, laryngeal edema and more intense manifestations such as shock and severe respiratory failure [5-9]; even the death of the patient, which has been described for the ionic contrasts of 1/20,000 and 1/100,000 and for the non-ionic contrasts of 1/200,000 and 1/2,000,000 [6]; although some authors describe a contrast mortality of 2-4 cases



**Figure 20:** In abdomino-pelvic angio-CT, coronal MIP view - of control, type III endoleak was observed.



**Figure 21:** Remodeling of the residual aneurysmal sac was observed.



**Figure 22:** Abdominal-pelvic CT angiography after administration of IV contrast in axial planes. Endotension example. In the left image of control at 6 months of EVAR and in the image of the right control at 18 months after EVAR in which growth of the residual aneurysmal sac is observed without evidence of leakage inside the residual aneurysmal sac.

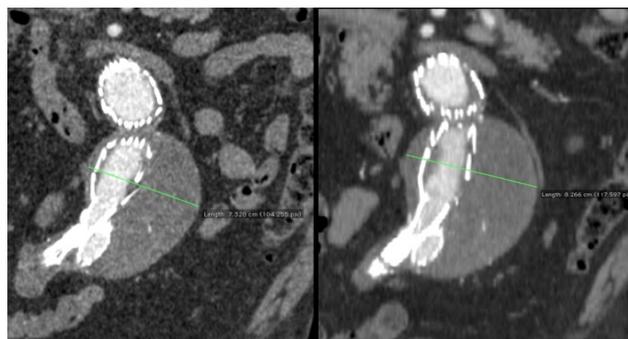
/1,000,000 regardless of the type of contrast [7,9]. In addition, the cost of a CT angiography is higher than that of an EDP (Figures 24-26).

### Materials and Methods

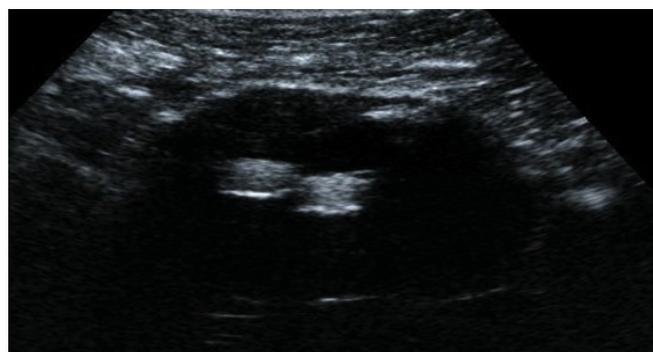
Of all patients with AAA treated by EVAR in our Prince Bijey Singh memorial hospital and to whom controls are being performed, 22 patients were randomly selected.

The informed consent of the patients was obtained both for the

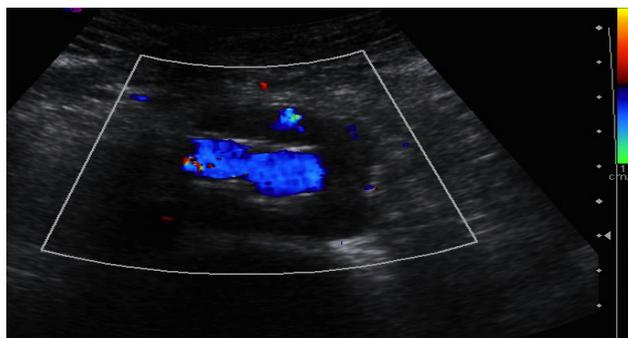
performance of the control CT angiography and for the realization of the EDP. All of them underwent first a CT angiography and then the EDP. Two radiologists, one with 21 years of experience in EDP and the other radiologist with 3 years of experience in angio-CT, independently analyzed the results of the tests without knowing the results of the other test.



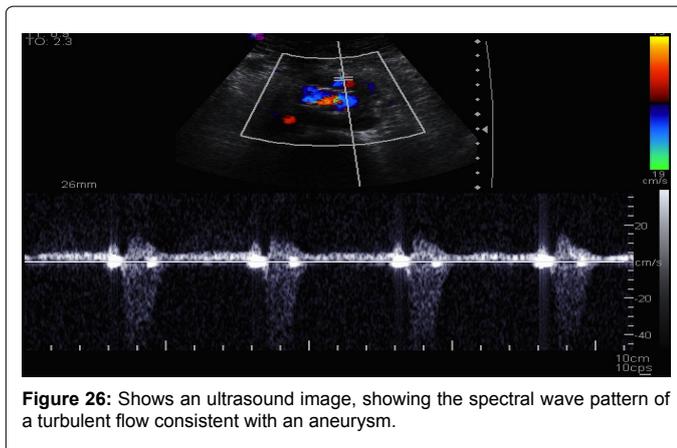
**Figure 23:** Abdominal-pelvic CT angiography after administration of IV contrast in coronal planes. Endotension example. In the left image of control at 6 months of EVAR and in the image of the right control at 18 months after EVAR in which growth of the residual aneurysmal sac is observed without evidence of leakage inside the residual aneurysmal sac.



**Figure 24:** Example of type II endoleak visualized in USG, as assessed both by abdomino-pelvic CT angiography with iv contrast and EDP. Note the great correlation between the two techniques.



**Figure 25:** Elucidates the pulsed Doppler ultrasound, showing arterial pulses in the interior of the residual aneurysmal sac.



**Figure 26:** Shows an ultrasound image, showing the spectral wave pattern of a turbulent flow consistent with an aneurysm.

The control CT angiography was performed with a 64 slice CT machine (Phillips Medical Systems, USA) and had the following characteristics: angio-CT pelvic-pelvic from xiphoid appendix to pubic symphysis with pitch of 1 to 1.5, collimation of 0.5 to 1 mm, reconstruction interval 1 to 1.5 mm with separation of 0.75 to 1 mm. KVp 120 to 140, and with automatic mA depending on the scanogram. Contrast flow at 4 ml/s, injecting the contrast into a forearm vein (basilic or cephalic). Sure start of 150-200 HU with ROI placed in adrenal abdominal aorta. 90-100 ml of iodinated contrast medium (iohexol) with a concentration of 300 mg I/ml and with subsequent contrast entrainment were used by injection of 25-30 ml of saline at 4 ml/s. Then, without removing the forearm path, the ultrasound study was performed.

The ultrasound examination was performed with a HITACHI PROSOUND ALOKA ALPHA A-7 with 4-10MHz convex probe. For the fundamental ultrasonography tissue harmonic (THI) was used, with frequency of insonation of 2.2 MHz, at 18-26 fps depending on the body morphotype of the patients, and with a dynamic range, between 55-60, performing the study in B mode in gray scale and color Doppler. The ultrasonography contrasted with an ultrasound enhancer was performed with the CCAI program, frequency of 1.3 MHz insonation, dynamic range 65 and low mechanical index (0.05). 2.4 mL of diluted microbubbles of sulfur hexafluoride were administered followed by infusion of 5 mL of physiological saline solution. Continuous visualization of the repaired aneurysm was carried out for 5 minutes for the detection of intraaneurysmal leaks.

The following parameters were analyzed:

- a) the sex and age expressed in years of the patients of the series.
- b) the height of the patients expressed in meters.
- c) the weight of the patients expressed in Kg.
- d) the body mass index (BMI) of the patients.
- e) the diameter of the residual aneurysmal sac expressed in mm, measured from wall to wall, in anteroposterior and transverse.
- f) the permeability or not of the endoprosthesis, assessed by the absence of thrombi and by the presence of flow inside the prosthesis: in CT angiography by contrast filler in the endoprosthesis and without filling defects; and in EDP by filling by the enhancer in the endoprosthesis and without filling defects.
- g) the existence or not of endoleaks and the type of said endoleak,

assessed by the presence of contrast or ultrasound enhancer inside the residual aneurysmal sac.

- h) the existence or not of infectious or other complications.

## Results

Of the 22 patients, in 95.45% of the cases (n=21) were male and 4.55% of the cases (n=1) were female. The mean age of the patients was  $73 \pm 7.7$  years (59-86) with a median of 73 years. The BMI body mass index was  $27.96 \pm 3.67$  (21.74-35.19) with a median of 27.68.

All implanted prostheses were bifurcated stent grafts. In 27.27% of the cases (n=6) Gore Excluder® AAA Stent graft excision was placed (WL Gore & Associates GmbH Unternehmensbereich Medizin Hermann-Oberth - Str. 22 85640 Putzbrunn Deutschland), and in a 72, 73% of the cases (n=16) were placed Zenith endografts from Cook Medical (William Cook Europe ApS Sandet 6, DK 4632, Bjaeverskov, Denmark).

The mean diameter of the residual aneurysmal sac measured by EDP was  $64.49 \pm 15.12$  mm (41.5-104) with a median of 63 mm and measured by angio-CT showed an average diameter of  $59.41 \pm 17.54$  mm (30-108) with a median of 59 mm. In spite of the differences that might appear when observing the data, if we apply Pearson's linear correlation test, we see that there is a perfect correlation between both, with a value of 0.958.

The control studies were carried out between 2-3 months after the implantation of the endoprosthesis. No study was performed in the first month after stent implantation.

Both techniques demonstrated permeability of the prosthesis in all patients.

Angio-CT identified a leak in 13.63% of the cases (n=3). The EDP demonstrated leakage in 31.82% of cases (n=7), all type II; in 85.72% of cases (n=6) they corresponded to hyperdynamic type II leaks (before 100 seconds) and 14.28% of cases (n=1) corresponded to hypodynamic type II leaks (after 100 seconds).

We analyzed the leak detection by EDP and correlated it with the BMI and observed that no differences were observed in the detection of leaks by EDP regardless of the BMI, even though we know that the BMI influences the transmission of the ultrasound or in the facility for visualization of deep structures; but we think that this result is due to the small size of the sample.

There was no complication related to the administration of the iodinated contrast or to the administration of the ultrasound enhancing medium.

The values of sensitivity, specificity, positive and negative predictive value of the EDP were: sensitivity 100%, specificity 79%, positive predictive value 43% and negative predictive value 100%.

## Conclusion

The EDP is a technique that does not irradiate, it can be used in patients in whom the use of iodinated contrast is contraindicated.

-It is more specific than angio-CT for detecting low-flow leaks, being able to consider it as the first modality of imaging in the follow-up of patients after EVAR.

-The EDP allows an economic saving since the angio-CT or angio-MR are more expensive than the realization of an EDP.

-Our results are in agreement with those published by other authors, but we need a wider series to give greater statistical strength to our results.

-There is a perfect correlation between the two techniques when assessing the diameter of the residual aneurysmal sac [10-15].

## References

1. Carrafiello G, Recaldini C, Lagana D, Piffaretti G, Fugazzola C (2008) Endoleak detection and classification after endovascular treatment of abdominal aortic aneurysm: value of CEUS over CTA. *Abdom Imaging* 33: 357-362.
2. Kranokpiraksa P, Kaufman JA (2008) Follow-up of Endovascular Aneurysm Repair: Plain Radiography, Ultrasound, CT / CT Angiography, MR Imaging / MR Angiography, or What ?. *J Vasc Interv Radiol* 19: S27-S36.
3. Lezzi R, Cotroneo AR, Basilico R, Simeone A, Storto ML, et al. (2010) Endoleaks after endovascular repair of abdominal aortic aneurysm: value of CEUS. *Abdom Imaging* 35: 106-114.
4. Perini P, Sediri I, Midulla M, Delsart P, Mouton S, et al. (2011) Single-center prospective comparison between contrast-enhanced ultrasound and computed tomography angiography after EVAR. *Eur J Vasc Endovasc Surg* 42: 797-802.
5. Cavalcanti Juchem B, Dall'Agnol CM (2007) Immediate adverse reactions to intravenous iodinated contrast on computerized tomography. *Rev Latino-am Enfermagem* 15: 78-83.
6. Fischer R, Bevacqua E, Arnolt R, Procope N, Portes R, et al. (2004) Adverse reactions produced by iodinated radiological contrast media. *Arch. argent. pediatr* 102: 65-71.
7. Méndez Fernández R, Graña López L, Rodríguez González R (2008) "Adverse reactions to contrast media." In: *Radiology contrast media. SERAM Monograph.* (Martí-Bonmati L and Pallardó Calatayud Y). 1st edition. Madrid: Editorial Panamericana, 115-128.
8. Ten Bosch JA, Rouwet EV, Peters C TH, Jansen L, Verhagen H JM, et al. (2010) Contrast-enhanced ultrasound versus Computed Tomographic angiography for surveillance of endovascular abdominal aortic aneurysm repair. *J Vasc Interv Radiol* 21: 638-643.
9. Méndez Fernández R, Graña López L (2009) "Drugs in radiology". In: *Essential radiology.* 1st edition. Madrid: Editorial Medica Panamericana, 65-77.
10. Ripollés T, Puig J (2009) Update of the use of contrasts in ultrasound. Review of the clinical guidelines of the European Federation of Ultrasound (EFSUMB). *Radiology* 51: 362-375.
11. Ali MU, Fitzpatrick-Lewis D, Miller J, Warren R, Kenny M, et al. (2016) Screening for abdominal aortic aneurysm in asymptomatic adults. *J Vasc Surg* 64: 1855-1868.
12. Wanhainen A, Hultgren R, Linné A, Holst J, Gottsäter A, et al. (2016) Outcome of the Swedish Nationwide Abdominal Aortic Aneurysm Screening Program. *Circulation* 134: 1141-1148.
13. Ito E, Toya N, Fukushima S, Murakami Y, Akiba T, et al. (2017) Aneurysm Wall Enhancement Detected by Contrast Computed Tomography Scan Is Associated With Aneurysm Shrinkage After Endovascular Aneurysm Repair for Abdominal Aortic Aneurysm. *Circ J.*
14. De Mestral C, Croxford R, Eisenberg N, Roche-Nagle G (2017) The Impact of Compliance with Imaging Follow-up on Mortality After Endovascular Abdominal Aortic Aneurysm Repair: A Population Based Cohort Study. *Eur J Vasc Endovasc Surg* 54: 315-323.
15. Keisler B, Carter C (2015) Abdominal aortic aneurysm. *Am Fam Physician* 91: 538-543.