Acta Angiol
Vol. 28, No. 2, pp. 63–68
DOI: 10.5603/AA.2022.0011

ISSN 1234–950X
e-ISSN 1644–3276

VIA MEDICA

CASE REPORT

Type 2 endoleak embolization and utilization of non-contrast-enhanced magnetic resonance angiography (NCE-MRA) as a non-invasive imaging follow-up method

Radosław Pietura[1], Joanna Elżbieta Kobak[2, 3], Kinga Kwolek[1], Stanisław Przywara[3], Tomasz Zubilewicz[3]

[1]Department of Radiography, Medical University of Lublin, Poland
[2]Medical University of Lublin, Poland
[3]Chair and Department of Vascular Surgery and Angiology, Medical University of Lublin, Poland

Abstract

Endovascular aneurysm repair (EVAR) is a minimally invasive technique widely used in abdominal aortic aneurysm treatment. The most common complications after EVAR are endoleaks, with type 2 endoleak (T2EL) being the most prevalent. T2EL detection and surveillance require imaging techniques such as computed tomography angiography (CTA), contrast-enhanced magnetic resonance angiography (CE-MRA), Doppler ultrasound, or digital subtraction angiography (DSA). However, these modalities are associated with numerous limitations, including exposure to ionizing radiation, contrast media administration, or operator dependency, as in the case of ultrasonography. A non-contrast-enhanced (NCE-MR) could be a substitute non-invasive method for endoleak monitoring.

Our case report describes an 83-year-old female patient with type 2 endoleak and enlarging aneurysm sac detected on a CT scan. Despite the enormous aneurysm size, the patient underwent endovascular treatment owing to multiple comorbidities. Due to challenging feeding vessel anatomy, catheterization of the aneurysmal sac was impossible. Attempted polymerization of the aneurysmal sac with Glubran-2 partially sealed the sac and obliterated the feeders' inflow. Unfortunately, a non-targeted embolization resulted in the loss of patency of the right feeder and adjacent communicating branch.

The patient underwent follow-up imaging that included non-contrast-enhanced as well as contrast-enhanced MRA. The examination revealed the presence of a small residual endoleak, a freshly formed thrombus, and areas of old thrombi. The NCE-MR appeared to be a valuable tool in endoleak detection and provided a detailed clot morphology.

Key words: endoleak, EVAR, magnetic resonance angiography, stent graft

Acta Angiol 2022; 28, 2: 63–68

Address for correspondence: Joanna Elżbieta Kobak, Medical University of Lublin, Aleje Racławickie 1, 20–059 Lublin, Poland, e-mail: kobak.joannaelzbieta@gmail.com

Introduction

Type 2 endoleak accounts for the most prevalent type of endoleak following endovascular aneurysm repair (EVAR) of the abdominal aortic aneurysm (AAA) and affects about 10% of patients after EVAR [1, 2]. It results from a retrograde filling of the aneurysmal sac by the feeding vessels. The most common culprit feeders include inferior mesenteric, lumbar, and internal iliac arteries. The less common ones are accessory renal or median sacral arteries. Most type 2 endoleaks (T2ELs) have a mild clinical course and do not require urgent intervention; however, approximately 1% of these endoleaks result in aneurysm sac rupture [3]. Despite the relatively high prevalence and availability of effective management, the routine treatment of type 2 endoleaks remains challenging and controversial [1, 4–5].

Based on the time of onset and duration, T2ELs are categorized as early (onset < 12 months after EVAR) or late/delayed (onset > 12 months after EVAR), and transient (resolved ≤ 6 months) or persistent (resolved > 6 months) [3]. As described by Pineda et al., early-onset T2ELs resolve without treatment in 75% of cases, while late-onset T2ELs self-resolve in only 29% of cases [6]. Furthermore, persistent T2ELs are associated with an increased risk of sac expansion, aneurysm rupture, re-interventions, and conversion to open surgical repair [7]. According to the Society of Vascular Surgery practice guidelines, T2EL treatment decisions should be based on the following criteria: the expansion of the aneurysm by ≥ 5 mm, the type and size of feeders, and the appearance of symptoms [4]. However, the European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines suggest that an enlargement of sac diameter by ≥ 10 mm, found during follow-up imaging on comparable scans, may be considered a valid threshold for significant sac growth and hence require re-intervention [3]. Primary treatment options include transarterial T2EL embolization and embolization via direct sac puncture. Transvenous, transcaval, transarterial perigraft, and transarterial transgraft account for other embolization approaches. Laparoscopic ligation of the supplying vessels and open surgical treatment are considered the last resort [1, 8].

Diagnosis, surveillance, and post-treatment follow-up of type 2 endoleaks require medical imaging. The most commonly used modalities encompass computed tomography angiography (CTA), contrast-enhanced magnetic resonance angiography (CE-MRA), digital subtraction angiography (DSA), Doppler ultrasound, and contrast-enhanced ultrasound (CE-US) [3–4, 9]. Unfortunately, these aforestated techniques are associated with numerous limitations. CTA and DSA require exposure to ionizing radiation and iodine contrast media administration, which carries a risk of renal injury, life-threatening allergic reactions, or thyrotoxicosis [9]. Regarding CE-MRA, gadolinium deposition in the brain and the bones was recently described [11, 12]. Furthermore, in patients with renal insufficiency performance of contrast-enhanced studies may be unfeasible [13, 14]. That is true for both MR and CT examinations since they possess similar eGFR level restrictions. Doppler and CE ultrasound are heavily operator-dependent, difficult to reproduce, and limited by patients' body habitus [9, 10]. Additionally, a comparison of aneurysmal geometry using these studies is challenging, especially considering variable aneurysm growth.

Hence, a non-contrast-enhanced (NCE-MR) could be an optimal, non-invasive imaging method practical for both diagnosis and surveillance of endoleaks [10].

Case report

An 83-year-old female patient presenting with abdominal pain and increasing abdominal circumference was referred to our clinic due to evidence of aneurysmal sac expansion detected on contrast-enhanced CT.

The patient had undergone EVAR of the AAA with Excluder stent-graft implantation seven years earlier (in 2015). The aneurysmal sac measurements preceding implantation with regard to the largest diameter and surface area were around 60,1 mm and 2427,3 mm^2, respectively (CE-CT in 2014). The same aneurysm sac parameters at the time of symptomatic enlargement measured about 152,2 mm and 12521,8 mm^2 (CE-CT in 2022). After the EVAR, the patient was under ultrasound surveillance, although the control examinations were quite unsystematic. The CT findings on admission were equivocal regarding the endoleak feeding sources, and the surgical repair was ill-advised owing to multiple patient comorbidities, which prompted an endovascular intervention to precisely localize and treat the endoleak. DSA confirmed type 2 endoleak supplied by two tortuous branches originating from the right and left internal iliac arteries and measuring about 3 mm in diameter (Fig. 1). The feeders exhibited a communicating branch and a shared inflow to the aneurysmal sac.

Despite multiple attempts, catheterization of the aneurysm sac via both feeding branches was unsuccessful. The reason was predominantly significant tortuosity and critical stenosis of the vessels. At this point, the typical onyx embolization was not achievable. That led to an effort to polymerize the sac via the right feeder using Glubran-2. The administration of a 16% mixture of cyanoacrylate glue and lipiodol resulted in partial polymerization of the aneurysmal sac and closure of the endoleak inflow site (Fig. 3). Additionally, given

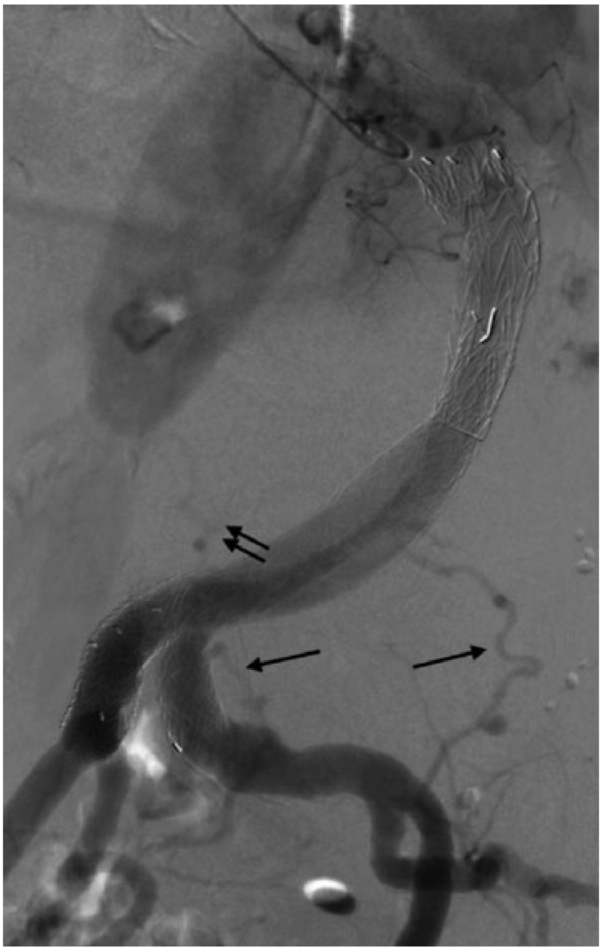

Figure 1. Endoleak feeding branches originating from the right and left internal iliac arteries (single arrows) and communicating branch connecting the right and the left feeder (double arrows)

the technical difficulties of using endovascular glue, the embolic agent obliterated the right feeding artery and the communicating branch connecting both feeders.

Four days following the embolization, the patient underwent MRA of the abdomen and pelvis using SIGNA Artist 1,5T GE. The sequences included 3D IFIR, FIESTA fs, 3D Heart, and LAVA, pre- and postcontrast administration. The NCE-MRA accurately visualized the size of the aneurysmal sac and the morphology of its contents. The largest diameter and surface area of the sac post-embolization were around 144,2 mm and 10466,4 mm^2, respectively. Multiple hyperintensity

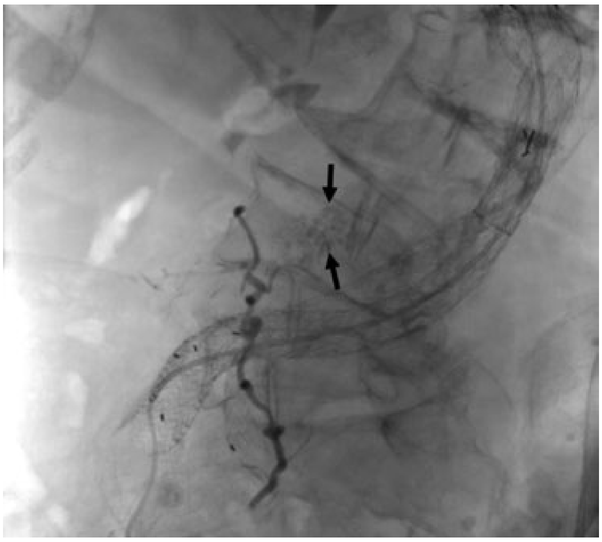

Figure 3. Non-target embolization of the right feeding artery and the adjacent communicating branch. Arrows point to an embolic agent polymerized inside the aneurysm sac

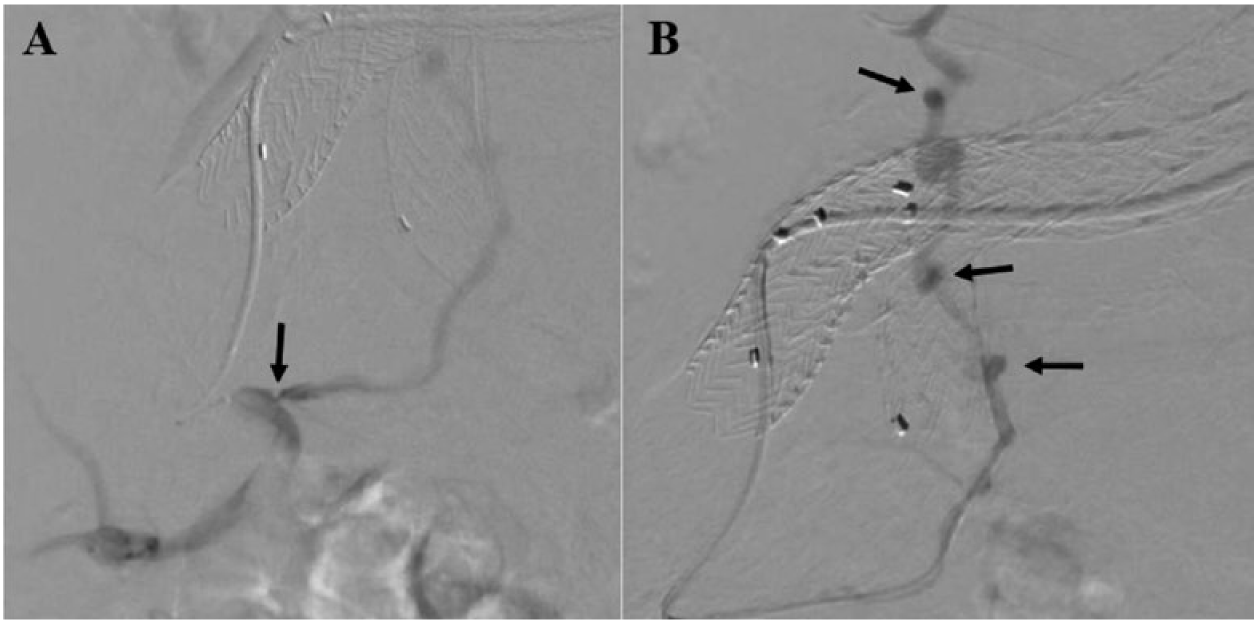

Figure 2. Challenges encountered during the catheterization of the feeding vessels. Arrow indicates stenosis of the feeder (A). Arrows indicate tortuosity of the feeding branch (B)

areas visible within the aneurysm sac on the 3D Heart sequence represented old thrombi. A hypointense area detected inside the sac on the 3D Heart sequence corresponded to a fresh thrombus with residing cyanoacrylate glue particles. Additionally, the non-contrast sequences allowed for the visualization of a small residual endoleak (Fig. 4).

Since it was our first attempt to use NCE-MR as a surveillance method after endoleak embolization, the examination was supplemented by contrast media administration. CE-MRA confirmed the leak of the contrast media into the aneurysm sac corresponding to the inflow of fresh blood, as identified on NCE-MR (Fig. 5). In our opinion, the NCE-MRA allowed for the depiction of the morphology of the aneurysmal sac contents, especially the distinction of the age of the thrombus. The patient was scheduled for an NCE-MR follow-up to track the progress of aneurysmal sac clot formation.

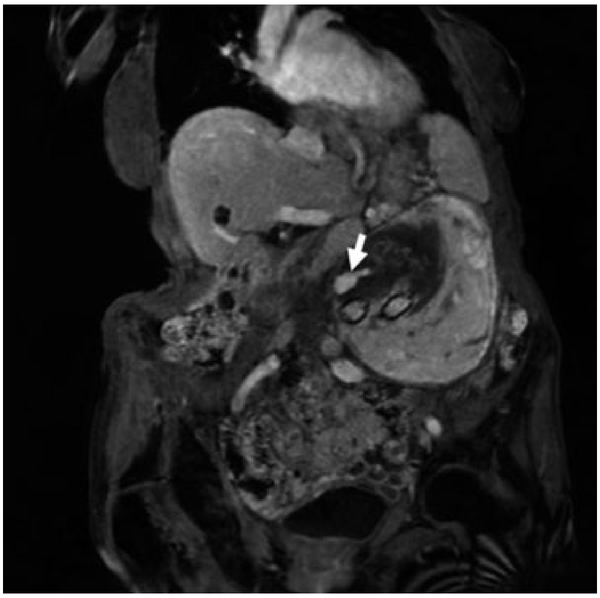

Figure 5. The T1-weighted CE-MRA sequence visualized contrast leakage into the aneurysm sac, proving the presence of the residual endoleak (corresponds to fresh blood inflow area visible on NCE-MRA; see Fig. 4 A, B)

Discussion

Type 2 endoleak embolization may prove exceedingly challenging due to unpredictable feeding vessel anatomy. Troublesome characteristics of feeders may include variable origin, tortuosity, or critical stenosis. Moreover, access through internal iliac arteries compared to the one through the arc of Riolan makes manipulation of the catheter more difficult due to multiple acute angles that need to be passed. Thus, catheterization and satisfactory embolization of the aneurysm sac may not always be achievable. Ideally, the obliteration would involve the liquid part of the sac and both inflow and outflow sites of the endoleak. Unfortunately, such a situation is often impossible.

Arenas Azofra et al. studied technical and clinical success following T2EL transarterial embolization (TAE). The authors defined it as a lack of endoleak on control angiography (technical) and a lack of sac growth by ≥ 5 mm detected on contrast-enhanced CT

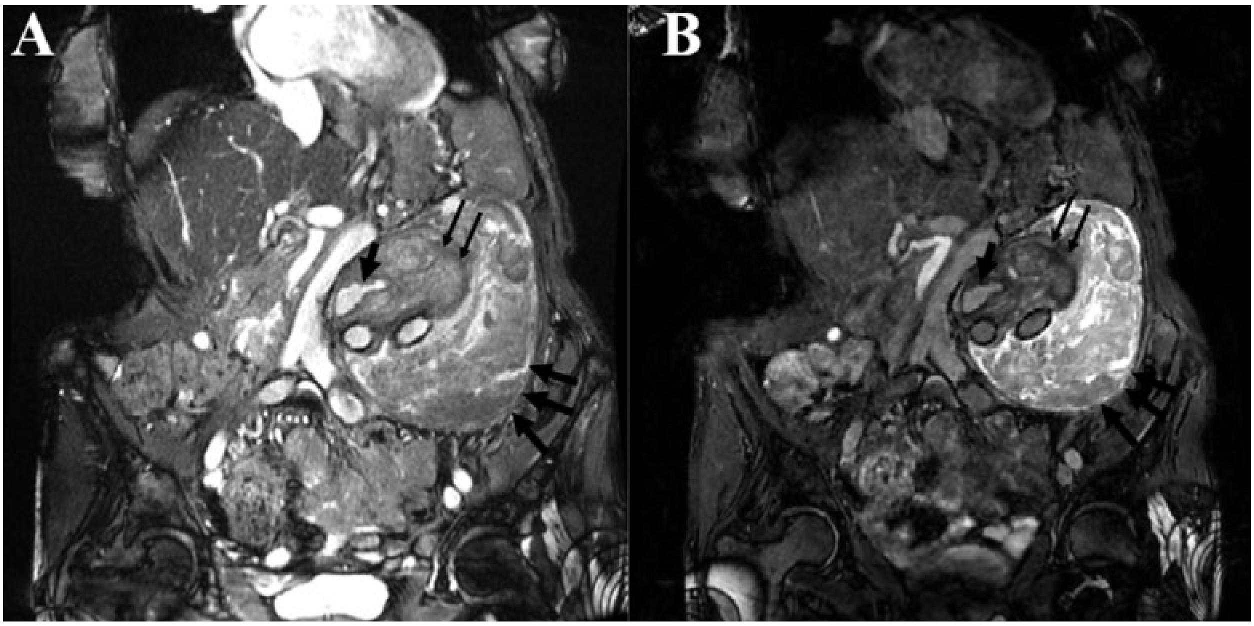

Figure 4. The NCE-MRA visualized the inflow of fresh blood into the aneurysm sac (single arrow), fresh thrombus inside the sac (double arrows), and organizing thrombus with retraction spaces (triple arrows). FIESTA (A). 3D Heart (B)

one year postembolization (clinical). The former was achieved in 71%, while the latter in 63% of cases. The re-intervention rate was about 36% [15].

Furthermore, Horinouchi et al. [16] suggested that an aneurysm sac diameter exceeding 55 mm at initial type 2 endoleak TAE is a significant predictor of aneurysm sac expansion. The authors advise performing TAE of the T2ELs before the sac reaches such a diameter. Moreover, the investigators concluded that T2EL TAE is not always an efficient way to prevent sac expansion, and further re-interventions may be necessary.

The mentioned earlier studies may prompt a conclusion that the availability of a reproducible, non-invasive, and precise diagnostic imaging modality is critical.

Presently, the gold standard for endoleak surveillance is a contrast-enhanced CT; however, observation of sac enlargement is possible using Doppler ultrasound, magnetic resonance imaging (MRI), or CT is possible without contrast media administration [3–4, 16]. Nevertheless, sac growth over 5 mm requires further evaluation by contrast-enhanced CT [4]. Notwithstanding, Habets et al. [17] implied that CE-MRA might be more sensitive in the detection of T2ELs in comparison to CE-CT.

A recent study by Salehi Ravesh et al. [9] proposed that NCE-MRA may yield better anatomical and functional insight into the distinct endoleak types than CTA or DSA. NCE-MRA provided a satisfactory evaluation of the aortic aneurysms, including their hemodynamic parameters and the contents of their sacs. Nonetheless, the study was limited by a small number of patients, different types of aortic aneurysms treated, high diversity of endovascular prostheses implanted, and variability of endoleaks detected.

In their study, including 46 patients with AAA and/or common iliac artery aneurysms treated with EVAR, Kawada et al. reported endoleak detection sensitivity, specificity, and accuracy of NCE-MRA endoleak detection as 77%, 92%, and 85%, respectively. This study's limitations included early post-operative NCE-MRA examination and different types of endoleaks identified. However, the authors concluded that NCE-MRA is a promising imaging technique for post-EVAR patient surveillance [10].

Similarly, the findings presented in our case report suggest that non-contrast-enhanced MRA may prove equally valuable in detecting residual endoleak post-TAE. In our experience, NCE-MRA allows for accurate evaluation of the aneurysmal sac size and enables a detailed analysis of the organizing thrombus.

As with any other imaging modality, NCE-MRA comes with its limitations. These mainly include classic contraindications to MR examination, i.e., the presence of implanted metallic and electronic devices or older types of stent grafts with metallic components. The newer stent graft technology allows for safe MR imaging. According to van der Laan et al. [18], four out of the currently available stent grafts (Excluder, AneuRx, Talent, and Quantum LP) should not compromise MR imaging. Some (the metal Zenith and the Lifepath) show ferromagnetic properties, causing artifacts obliterating stent-graft lumen and adjacent structures. Evaluation of the MR images in the case of the Ancure graft may also be problematic.

In summary, non-contrast-enhanced MRA is a reproducible imaging method that does not require exposure to ionizing radiation or contrast media administration, which could prove particularly useful in patients with end-stage kidney disease. The NCE-MRA may ensure safe and precise T2ELs monitoring following Excluder stent-graft implantation, providing insight into thrombus morphology and its organization. Clinical studies, including prospective randomized controlled trials, are needed to implement an optimal NCE-MRA protocol for endoleak surveillance.

Conflict of interest

None.

References:

1. Guo Q, Du X, Zhao J, et al. Prevalence and risk factors of type II endoleaks after endovascular aneurysm repair: A meta-analysis. PLoS One. 2017; 12(2): e0170600, doi: 10.1371/journal.pone.0170600, indexed in Pubmed: 28182753.
2. Chen JX, Stavropoulos SW. Type 2 Endoleak Management. Semin Intervent Radiol. 2020; 37(4): 365–370, doi: 10.1055/s-0040-1715873, indexed in Pubmed: 33071447.
3. Wanhainen A, Verzini F, Herzeele IV, et al. Editor's Choice – European Society for Vascular Surgery (ESVS) 2019 Clinical Practice Guidelines on the Management of Abdominal Aorto-iliac Artery Aneurysms. European Journal of Vascular and Endovascular Surgery. 2019; 57(1): 8–93, doi: 10.1016/j.ejvs.2018.09.020.
4. Chaikof EL, Dalman RL, Eskandari MK, et al. The Society for Vascular Surgery practice guidelines on the care of patients with an abdominal aortic aneurysm. J Vasc Surg. 2018; 67(1): 2–77.e2, doi: 10.1016/j.jvs.2017.10.044, indexed in Pubmed: 29268916.
5. Jonker FHW, Aruny J, Muhs BE. Management of type II endoleaks: preoperative versus postoperative versus expectant management. Semin Vasc Surg. 2009; 22(3): 165–171, doi: 10.1053/j.semvascsurg.2009.07.008, indexed in Pubmed: 19765527.
6. Pineda DM, Calligaro KD, Tyagi S, et al. Late type II endoleaks after endovascular aneurysm repair require intervention more frequently than early type II endoleaks. J Vasc Surg. 2018; 67(2): 449–452, doi: 10.1016/j.jvs.2017.05.124, indexed in Pubmed: 29389419.
7. Lo RC, Buck DB, Herrmann J, et al. Vascular Study Group of New England. Risk factors and consequences of persistent type

II endoleaks. J Vasc Surg. 2016; 63(4): 895–901, doi: 10.1016/j.jvs.2015.10.088, indexed in Pubmed: 26796291.

8. Yang RY, Tan KT, Beecroft JR, et al. Direct sac puncture versus transarterial embolization of type II endoleaks: An evaluation and comparison of outcomes. Vascular. 2017; 25(3): 227–233, doi: 10.1177/1708538116663992, indexed in Pubmed: 27538929.
9. Ravesh SM, Langguth P, Pfarr JA, et al. Non-contrast-enhanced magnetic resonance imaging for visualization and quantification of endovascular aortic prosthesis, their endoleaks and aneurysm sacs at 1.5 T. Magn Reson Imaging. 2019; 60: 164–172, doi: 10.1016/j.mri.2019.05.012, indexed in Pubmed: 31075419.
10. Kawada H, Goshima S, Sakurai K, et al. Utility of Noncontrast Magnetic Resonance Angiography for Aneurysm Follow-Up and Detection of Endoleaks after Endovascular Aortic Repair. Korean J Radiol. 2021; 22(4): 513–524, doi: 10.3348/kjr.2020.0001, indexed in Pubmed: 33543842.
11. McDonald RJ, McDonald JS, Kallmes DF, et al. Gadolinium Deposition in Human Brain Tissues after Contrast-enhanced MR Imaging in Adult Patients without Intracranial Abnormalities. Radiology. 2017; 285(2): 546–554, doi: 10.1148/radiol.2017161595, indexed in Pubmed: 28653860.
12. McDonald JS, McDonald RJ, Jentoft ME, et al. Intracranial Gadolinium Deposition Following Gadodiamide-Enhanced Magnetic Resonance Imaging in Pediatric Patients: A Case-Control Study. JAMA Pediatr. 2017; 171(7): 705–707, doi: 10.1001/jamapediatrics.2017.0264, indexed in Pubmed: 28531274.
13. Davenport MS, Perazella MA, Yee J, et al. Use of Intravenous Iodinated Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation. Radiology. 2020; 294(3): 660–668, doi: 10.1148/radiol.2019192094, indexed in Pubmed: 31961246.
14. Juneman E, Saleh L, Thai H, et al. The use of gadolinium in patients with contrast allergy or renal failure requiring coronary angiography, coronary intervention, or vascular procedure. Catheter Cardiovasc Interv. 2011; 78(5): 747–754, doi: 10.1002/ccd.22907, indexed in Pubmed: 21780275.
15. Arenas Azofra E, Rey VM, Marcos FÁ, et al. Results of Transarterial Embolization for Treating Type 2 Endoleaks: A Single-Center Experience. Ann Vasc Surg. 2020; 66: 104–109, doi: 10.1016/j.avsg.2019.05.020, indexed in Pubmed: 31381998.
16. Horinouchi H, Okada T, Yamaguchi M, et al. Mid-term Outcomes and Predictors of Transarterial Embolization for Type II Endoleak After Endovascular Abdominal Aortic Aneurysm Repair. Cardiovasc Intervent Radiol. 2020; 43(5): 696–705, doi: 10.1007/s00270-020-02436-2, indexed in Pubmed: 32140839.
17. Habets J, Zandvoort HJA, Reitsma JB, et al. Magnetic resonance imaging is more sensitive than computed tomography angiography for the detection of endoleaks after endovascular abdominal aortic aneurysm repair: a systematic review. Eur J Vasc Endovasc Surg. 2013; 45(4): 340–350, doi: 10.1016/j.ejvs.2012.12.014, indexed in Pubmed: 23403221.
18. van der Laan MJ, Bartels LW, Bakker CJG, et al. Suitability of 7 aortic stent-graft models for MRI-based surveillance. J Endovasc Ther. 2004; 11(4): 366–371, doi: 10.1583/04-1246.1, indexed in Pubmed: 15298496.