REPARAÇÃO ENDOVASCULAR DE ANEURISMAS – CONSIDERAÇÕES ACERCA DAS ESTRATÉGIAS DE SEGUIMENTO ATUAIS

ENDOVASCULAR ANEURISM REPAIR (EVAR) – CONSIDERATIONS ON CURRENT FOLLOW-UP STRATEGIES

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RESUMO

Os aneurismas da aorta abdominal (AAA) constituem uma patologia complexa, com consequências catastróficas se não forem adequadamente diagnosticados e tratados. Atualmente, a reparação de aneurismas endovascular (EVAR) tornou-se numa opção válida de tratamento para os AAA, com melhores resultados peri-operatórios quando comparada com a cirurgia aberta, e está a tornar-se rapidamente na opção preferida pelos pacientes. Contudo, a ocorrência de *endoleaks* está descrita como o evento adverso mais comum associado ao EVAR. Deste modo, revimos a definição e a classificação dos *endoleaks* bem como os seus potenciais riscos e a sua gestão. De acordo com os protocolos atuais de seguimento da Sociedade Europeia de Cirurgia Vascular (ESVS), esta técnica requer um longo seguimento por imagem, habitualmente realizado por angiografia tomográfica computorizada (Angio-TC), o que aumenta os custos e nos leva para a discussão acerca dos riscos da exposição à radiação. Relativamente a este último tópico, revimos também estudos selecionados e concluímos que a angio-TC ao 1º mês é o exame de imagem mais importante para o prognóstico do doente e, se não forem encontradas complicações, podem ser adotadas outras estratégias de seguimento por imagem para minimizar a exposição dos pacientes à radiação e, desta forma, os riscos.

Palavras-chave
EVAR; Seguimento; Angio-TC; Ecografia; Radiação

ABSTRACT

Abdominal aortic aneurysm (AAA) is a cumbersome pathology, with catastrophic consequences when not properly diagnosed and treated. Nowadays, EVAR became an established treatment option for AAA, with better perioperative outcomes when compared to open surgery, and is quickly gaining a position of preference among the patients. However, the occurrence of endoleaks is described as the most common adverse event associated to EVAR. Consequently, we review the definition and classification of endoleaks as well as their potential risks and management. Nonetheless, according to the current follow-up protocols of ESVS, this technique requires an extensive imaging follow-up, usually by means of computed tomographic angiography (CTA), which carries increased economic cost and leads us to discuss related great radiation hazards. Concerning the latter, we also review the selected studies and we concluded that the first month CTA is the single most important imaging exam for patients' prognosis and, once no complications are found, other reviewed imaging follow-up strategies should be undertaken to minimize radiation exposure and yet further risks for the patients. Therefore, this article establishes an overview about the current evidence and future strategies on EVAR imaging follow-up.

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Keywords
EVAR ; Follow-up; CTA; Ultrasound; Radiation

INTRODUCTION

Abdominal aortic aneurysm (AAA) is a cumbersome pathology, with catastrophic consequences when not properly diagnosed and treated. It is defined as a focal dilatation of the aorta with at least one and half times its normal diameter (measured at the level of the renal arteries)[1], and usually corresponds to a diameter greater than 3 cm[2]. Several risk factors for AAA development are known, and include age (> 60 years), male gender, smoking, hypertension, hypercholesterolemia and family history[1,3]. In most cases, this pathology is asymptomatic until impending rupture and is usually incidentally diagnosed on abdominal radiologic exams[1]. Most AAA only become symptomatic when complications develop, being rupture the most common[4]. A diameter > 6 cm, expansion rate over 0.6 cm/y, severe smoking, poorly controlled hypertension, family incidence, eccentric shape, high wall stress and female gender are associated with a higher risk for rupture[5]. When ruptured, overall mortality rates exceeds 80%, and therefore elective treatment should be performed as much as possible. There are two main surgical options for elective AAA surgical repair: open surgery (OR) and endovascular aneurysm repair (EVAR). When EVAR was first introduced, it became an established treatment option for AAA and several studies have been performed in order to compare the outcomes of both techniques. Regarding 30-day mortality, morbidity, recovery, and in-hospital and ICU stay, better perioperative outcomes for EVAR have been demonstrated[6-8]. Furthermore, it is also acknowledged that the endovascular approach has become the primary choice between the patients[6]. Nonetheless, early benefit of this technique is lost at long-term, with some studies reporting no survival differences among groups[9,10] or even more re-intervention and a higher aneurysm-related mortality rate for the endovascular repair.[7,11]
Secondary aneurysm rupture, despite rare, seems to be one of the causes for long-term EVAR loss of benefit[7,10,11]. Therefore, long-term surveillance after EVAR must be performed, assessing endograft position, aneurysm size and presence or absence of endoleak[2]. This has been regarded as an important downside on EVAR, as long-term follow-up carries high radiation exposure for the patient, with consequent medical and economical implications. Moreover, a recent systematic review has accessed the impact of patients' non-compliance in the EVAR surveillance and statistically significant results revealed higher re-interventions rates from 3 to 5 years post-EVAR in the compliant group, although, no significant differences on patient's 1 to 5-years survival were found comparing to the non-compliant patients[12].
Through this article, we aim to review current evidence on EVAR imaging follow-up.

ENDOLEAK – DEFINITION, CLASSIFICATION, IMPORTANCE AND SURVEILLANCE

Endoleak defined as the flow of blood into the aneurysm sac, between the aortic wall and the endograft, is the most common complication after EVAR, affecting 20 to 25% of patients[13-15]. Morphologic factors such as aneurysm size, angulation of the infrarenal neck (β), patency of inferior mesenteric artery, and sac thrombus[15] were related to an increased risk of endoleak. Some demographic factors such as older age and female sex[16] were also related with this complication. Despite smoking being a known risk factor for aneurysm development, the risk of endoleak post-EVAR seems to be smaller in smokers[16].
There are several types of endoleaks, which can be differentially classified depending on their origin:

Type I endoleak

In type I endoleak, flow arises from the endograft attachment site. It can be divided in type Ia when proximal seal is compromised, type Ib when distal seal is compromised and type Ic when backflow from an occluded limb is found.
Type Ia is a particularly serious endoleak, as direct antegrade arterial blood flows inside the aneurysm sac. There are certain baseline anatomic characteristics that increase the risk for this type of endoleak, such as short, angulated, ulcerated, reverse-tapered, and thrombus-containing necks[17].
When a type I endoleak is present, re-pressurization of the aneurysm sac occurs, which leads to further growth and eventually aneurysm rupture, and therefore, re-intervention is mandatory.

Type II endoleak

Type II endoleak is defined by the presence of backflow from a collateral vessel leaking directly into the aneurysm sac, usually the inferior mesenteric (Type IIa) or lumbar arteries (type IIb).
In the past, type II endoleaks were reported as single markers of worse outcome, being associated with several complications and difficult management. Nowadays we know that unlike type I endoleak, the prognosis of primary type II endoleaks is usually benign, as these can spontaneously thrombose. In fact, a recent work has shown that if a type II

endoleak is present without an associated increase in size of the aneurysm sac, there is no need for immediate intervention, but only continuous follow-up, as with time, the rate of spontaneous resolution increases[18].
Nonetheless, the clinical significance of type II endoleak has not been totally established, since some persistent type II endoleaks can been associated with an increased incidence of adverse outcomes, including sac growth, re-intervention rate, the need for conversion to open repair, and rupture[19].

Type III endoleak

Type III endoleak is attributed to structural failure of the stent graft, and usually results from loss of seal in overlapping components of the graft. It is very rare (2–3%), with a higher incidence in first and second generation grafts[20], *probably due to low flexibility and low surgeon experience. Most type III endoleaks should be treated and most cases can be managed endovascularly*[21].

Type IV endoleak

Type IV endoleak results from the passage of blood through the endograft fabric into the aneurysm sac, due to increased porosity. It was classically described in first and second generation endografts[22] *but nowadays, with the improvements in the fabric used, are almost restricted to some type of FEVAR endografts, mainly due to the holes left from the diameter reducing ties*[23]. *No adverse outcomes have been reported from this complication.*

Type V endoleak

Type V endoleak, also called endotension, is a poorly understood phenomenon. It is thought to occur when increased graft permeability allows pressure to be transmitted through the aneurysm sac. Nonetheless, some authors believe type V endoleaks do not exist, and are simply undiagnosed endoleaks due to poorly acquired CTA images.

Regarding the time of presentation, endoleaks can be classified as primary, if they occur within 30 days after graft deployment, or secondary, when they appear in the period thereafter[17]*; delayed endoleaks refers to those appearing over a year post-EVAR. Some authors reported that delayed endoleaks are the majority and that are significantly associated with aneurysm sac growth*[24]. *This complication is the most frequent cause of AAA rupture after EVAR*[25], *especially type Ia and Ib*[26], *and consequently the most common indication for reintervention*[14,26].
Long-term imaging follow-up is therefore necessary for proper diagnosis and treatment of complications.

CURRENT FOLLOW-UP PROTOCOLS - SOCIETY FOR VASCULAR SURGERY RECOMMENDATIONS

For surveillance of endografts after EVAR, the Society for Vascular Surgery recommends contrast enhanced CT imaging (CTA) at one and 12 postoperative months, with an additional CTA at six months if the first exam identifies a type II endoleak or other abnormality[3]. *Furthermore, 6-months interval surveillance with color Duplex ultrasound (DUS) for 24 months should be performed once a type II endoleak, associated with an aneurysm sac that is shrinking or stable in size, is present, with subsequent annual following*[27]. *If neither endoleak nor AAA enlargement were observed during the first year after EVAR*[3], *DUS is an alternative to CTA for sequential annual surveillance*[28].
Additionally, it is suggested a noncontrast-enhanced CT imaging of the aorta every 5-years interval after OR or EVAR[27].
Although there are no specific recommendations towards patients with chronic kidney disease (CKD), and once CTA is associated to nephrotoxicity, it is recommended the use of US when feasible for following purposes.

RADIATION HAZARDS IN EVAR FOLLOW-UP

Elective patients planned for EVAR are exposed to radiation during the preoperative investigations, procedure, and at least 1 year of surveillance. This results in a 45.5 to 62 mSv radiation exposure in a 1-year period[29,30], *which is 30 times higher than the natural background radiation*[30], *and is responsible for an estimated excess of mortality of 1 per 400*[30], *causing up to 1% additional lifetime risk of fatal cancer development*[31].
Younger patients, women and those submitted to several CT exams have higher risk for radiation-related cancer[32].
Radiation is a well-known risk factor for cancer, and therefore the benefit of exposing patients to further postoperative radiation must be considered. In fact, it was demonstrated that less than 10% of patients benefit from periodic CT imaging after EVAR[33]. *Some authors reported that only 43% of post-EVAR patients had a complete surveillance and that neoplastic diseases were significant predictors of follow-up fulfillment*[34].
In fact, the 3 year follow-up of IMPROVE trial demonstrated that the approach of survival rates between EVAR and OR identified for this period of follow-up was not due to aortic related events, but in fact due to the increase of cancer related deaths in the EVAR group[35]. *This fact reinforces the need of rethinking the CT scan-based follow-up strategy, as most of patients who undergo it are also highly exposed to other carcinogenic agents related with their comorbidities (ex: cigarette smoke).*

Besides the effect of radiation, contrast administration related with CTA scans is also associated with renal function decline in post-EVAR patients, which, according to the current evidence, have a higher baseline incidence of chronic kidney disease than general population[36].

THE IMPORTANCE OF THE 1ST MONTH CTA

First month CTA imaging is the single most important imaging exam to predict the prognosis of post-EVAR patients. On one hand, the majority of endoleaks at the completion arteriogram disappear within the first month[15,16], which demonstrates that first-month CTA scan provides a reliable prospection of endograft placement and aortic seal, therefore acting as a good predictor for reinterventions or complications. On the other hand, evidence shows that a normal CT scan at 1 month post-EVAR has more than 95% negative predictive value concerning the need for reintervention[37-39].

In fact, there are several studies, which aim to evaluate the role of the 1st month CTA as a predictor of outcome. Kirkpatrick et al[37] examined all follow-up CTA scans of 91 post-EVAR patients and correlated the findings with the future development of complications and need of secondary interventions. The authors found a 92.9% negative predictive value for complications and a 97.1% chance of not requiring a reintervention in patients with a normal 1st month CTA. On another example, Patel et al[38], in the Powerlink endograft clinical trial, reviewed 345 post-EVAR subjects and concluded that among the patients with normal 1st month CTA, there was a 96.4% chance of not requiring secondary intervention.

Bastos-Gonçalves et al[39] stratified a group post-EVAR patients in a low and high-risk group using baseline anatomic seal lengths (more or less than 10mm) and the absence of endoleak in the first CTA as risk criteria. From their study, they concluded that among the 47% patients meeting the criteria for low-risk group, only 2% required reintervention, with no delayed endoleaks diagnosed for the considered follow-up. By contrast, 38% of the high-risk group patients developed complications in the follow-up period. Sternbergh et al[40] showed that the absence of endoleak in the first-month CTA scan of 714 patients treated with Zenith Endograft was associated with a 85.4% negative predictive value for reintervention. Unlike previous reports[37-39], this study used endoleak as the sole criterion for the prediction of complications, not considering other variables such as adequate seal.

ALTERNATIVES TO SERIATED FOLLOW-UP CTA'S

In recent years, radiation awareness has dramatically increased and with it, the importance of seriated CTA scans in EVAR follow-up has been questioned. Dias et al demonstrated that simple diameter measurements, together with control of the structure stability of the stent-graft, would identify the majority of asymptomatic patients requiring a re-intervention, with no need for CTA[33]. This has been reinforced by some studies reporting that aortic diameters measured by US provide a similar reliability than the actual gold-standard CTA protocols[41] with some authors reporting that DUS major diameter measurements appears to be the most accurate estimation of aortic diameter post-EVAR[41]. Contrast-enhanced color duplex ultrasound and three-dimensional contrast-enhanced ultrasound have also been stated to be an accurate radiation-free option[27,42,43]. Other study reports direct pressure measurement of intra-aneurysm sac pressure after EVAR, although invasive, is reliable and reproducible[44]. A non-invasive method of pressure measurement is also described but carries more interference if a mural thrombus is present[45]. Despite the fact that the latter fails in access device integrity, its value in the evaluation post-EVAR should be considered but not as an isolated surveillance strategy[45,46].

DOPPLER ULTRASSOUND BASED PROTOCOLS

The role of DUS as a safe alternative for CTA in EVAR follow-up has been extensively studied in the last years, with some authors reporting EVAR follow-ups performed exclusively by this technique.

In a recent study by Schaeffer et al[47], 174 patients with favorable pre-operative baseline anatomy and treated by EVAR (strictly inside the IFU's) were exclusively assessed by DUS. No clinically significant adverse events were found at 3,2 years of follow-up. Despite avoiding nephrotoxicity and radiation, DUS carries a significant inter-operator variability in skill and technique. What concerns to the graft integrity and its position/kinking, DUS presents itself as poor estimation approach[48]. Moreover, the equipment's properties also reflect the quality of the imaging results alongside the lack of standardization in measurement criteria[43]. Nonetheless, certified professionals by vascular labs and accredited institutions are imperative for

enhanced results' homogeneity. It is also stated that vascular labs should report theirs results and the variability between operators and intra-operators[43].

There is therefore a growing body of evidence suggesting that, not only do we need different strategies to reduce radiation exposure, but there are also already some imaging options available that can be used to do so without compromising the surveillance.

CONCLUSION

In recent years, radiation awareness and economic-driven reasons have prompted the search for alternatives to seriated follow-up CTA's. Evidence shows that the 1st month CTA is the single most important imaging exam to predict the prognosis of post-EVAR patients, but when no abnormalities are found, seriated CTA's are unnecessary and can be substituted by less hazardous imaging techniques. Also, pre-operative patient-specific characteristics are known to influence the risk of late complications and should be taken into account in each patient follow-up protocol. Alongside, patients' characteristics and perioperative data could be recorded for later risk stratification in developing adverse events or the need of re-intervention. However, stratification of the risks, beside possible, still demands a prospective validation[49].

Although late failure can be multifactorial and therefore not totally preventable with any surveillance regimen, this evidence should prompt patient-tailored imaging follow-ups, stratified and adapted according to the patient-specific risk of complications. In the future, unlike the commonly adopted surveillance intervals in current AAA guidelines, surveillance intervals of several years and ultrasound driven protocols might be clinically acceptable for the majority of patients. Additionally, to achieve a better improvement of the surveillance, a specialized and directed appointment for patients' follow-up in the same institution would be a suitable approach. Nonetheless, in spite of aforementioned evidence, CTA scan remains essential whenever adverse events are suspected.

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