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Isabel Maria da Costa Viana

Endovascular solutions for type IA endoleak after endovascular aneurysm repair

Soluções endovasculares para endoleaks tipo IA após reparação endovascular de aneurisma da aorta abdominal

ABRIL, 2021

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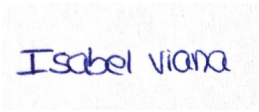

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Endovascular solutions for type IA endoleak after endovascular aneurysm repair

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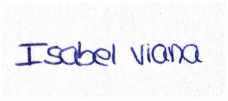

Dedicatória

A ti, pai.

À minha mãe, pela força que tem e pela força que me transmitiu ao longo da vida.

Por nunca me deixar ir abaixo. Pela alegria e pela bondade.

Por tornar tudo isto possível.

Aos meus avós, por estarem lá.

Por tudo o que me ensinaram e por acreditarem em mim em todas as circunstâncias.

A eles, por serem o maior exemplo que poderia pedir, um sincero obrigada.

À minha família, pela união e pelo carinho.

Ao meu namorado, por nunca me deixar desistir.

Pela paciência e pelo amor.

Endovascular solutions for type IA endoleak after endovascular aneurysm repair

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What this paper adds

Type IA endoleak significantly increases the risk of post-implant rupture and expedite repair is necessary. There are currently available several endovascular solutions for the treatment of type IA endoleaks, each one claiming advantaged in different scenarios and anatomies.

The present review provides detailed description of each technique along with respective short and midterm outcomes, in order to provide guidance to which methodology has greater technical success and durability. Moreover, this paper includes a review on the outcomes of type IA endoleaks that are resistant to intra-operative treatment. Most of these endovascular approaches show promising results. Nevertheless, it is still premature to have a fixed choice over the others, as anatomies and clinical scenarios demand different solutions. Larger studies, comparing directly these endovascular solutions, are needed to clarify the best approach.

ABSTRACT

INTRODUCTION: Endovascular aneurysm repair (EVAR) has largely overcome open surgery for Abdominal Aortic Aneurysm (AAA) repair and stands for the preferred method. Type IA endoleak (E1A) is a well-known EVAR-specific complication with an incidence of 3.5-15.5%. There is consensus on the expedite need for E1A correction due to continuous sac pressurization. Many possible approaches are available to correct E1A. The present review aims to describe endovascular options for E1A repair.

MATERIAL AND METHODS: MEDLINE databases were searched in order to find the available evidence on the management of persistent E1A. The research included articles between January 2010 and October 2020.

RESULTS: Seventeen studies were included with a total of 320 patients. The primary technical success was higher with Endovascular Aneurysm Sealing with or without chimney, with endoleak sealing rates up to 100%. Regarding reintervention rates, EndoAnchoring presented fewer incidence. Freedom from endoleak at the end of follow-up (FU) was higher with proximal cuffs and Chimney EVAR (ChEVAR). For conservative approach, the results show reintervention rates between 4-11% and freedom from endoleak at the end of FU with or without treatment around 90%.

CONCLUSIONS: Several techniques are currently available for E1A repair. Nonetheless, larger studies are needed to understand which techniques are better for each case.

KEYWORDS: “Abdominal Aortic Aneurysm”, “Type IA endoleak”, “Endovascular Aneurysm Repair”

INTRODUCTION

Endovascular aneurysm repair (EVAR) is the preferred modality of Abdominal Aortic Aneurysm (AAA) repair. Despite lower invasiveness and short-term mortality benefits, EVAR has some specific caveats, which require long term surveillance [1].

Endoleaks represent one of the most common complications, which can be found in 20-50% of the cases [1, 2]. Endoleaks are classified in four types: a type I endoleak is when there is an incompetent seal of the graft and a blood flow to the aneurysmal sac persists. It can be proximal (type IA, E1A), distal (type IB) or caused by an inadequate seal in an iliac plug (type IC). These are considered the most threatening because they have the highest risk of rupture as the aneurysm sac remains under systemic pressure. Leakage of blood due to collateral vessels is defined a type II endoleak. This is the most common but has a low risk of rupture and usually resolve without any treatment. A type III endoleak results from a separation of any components of the grafts or a fabric tear. Finally, a type IV endoleak is caused by material porosity and develops in the early postoperative phase [1].

The development of E1A can occur in more than 10% of EVARs [3, 4]. Several risk factors for E1A are described: short, angulated and wide proximal necks, thrombus burden and significant calcification. Some E1A are evident during the EVAR procedure for which correction should be promptly attempted [4]. Some endoleaks are detected over the follow-up (FU) period and may result from graft migration or proximal neck aneurysmal degeneration.

Back in the beginnings of EVAR, most E1A were converted to open repair in order to arrest sac growth. However, technological improvements permitted endovascular

correction of E1A, with significantly less invasiveness. Therefore, the aim of this paper is to review endovascular options for E1A repair.

MATERIAL AND METHODS

Study design and literature search

A literature search was performed on MEDLINE databases in order to collect studies regarding the management of type IA endoleaks after EVAR. Articles from January 2010 until October 2020 were included. The keywords used were “Abdominal Aortic Aneurysm”, “Endovascular Aneurysm Repair” and “Type IA Endoleak”. Inclusion criteria were as follows: any study in a clinical setting the English language that addressed the elective and emergent management of type IA endoleaks published between January 2010 and October 2020.

After relevant titles were identified, all the abstracts were read and eligible studies were retrieved. A cross-reference search was then performed to identify other studies not found in the primary query. Duplicates were excluded. Finally, the full text was analysed. Non-original studies were excluded.

In each study, we analysed the number of patients included, patient selection, technical success, complication, mortality, FU time and endpoints.

RESULTS

Our initial research included 154 articles, from which 17 were selected to include in this review.

Of these 17 studies, three were related with conservative treatment (n = 82), another three with proximal cuffs (n = 58), three other articles with embolization (n = 18), three with EndoAnchors (n = 78) and three more with Endovascular Aneurysm Sealing /Chimney EVAS (ChEVAS) (n = 21). Finally, the last two articles were about Chimney EVAR (ChEVAR) (n = 63). A total of 320 patients were analysed. Table 1 and Table 2 summarise the main results of the studies included.

Conservative Approach

Primary endoleaks are visible on the completion angiogram during the procedure. Despite treatment of all E1A being recommended by current guidelines [1], there are some studies analysing the possibility of spontaneous endoleak sealing after failure of several endovascular approaches, especially when we consider small endoleaks.

Recent studies have proved that immediate E1A may not be as dangerous as previously thought. In fact, the endoleaks that fail to resolve in the operating room, show low rupture rates and aneurysm-related mortality and high spontaneous sealing rates [4, 6]. There are several studies reporting the results of a conservative approach for primary endoleaks in selected patients with suitable anatomy for EVAR.

In a review by O'Donnell et al., of 122 patients with E1A on final intra-operative angiography, only 43 (35%) remained after additional ballooning of the proximal site or placement of an aortic cuff. Of these, only 13 (10.6%) persisted at 30 days and six (5%) after one year. Reintervention rate was 11% and three (2.4%) patients had an aneurysm rupture. The persistence of endoleak was not associated with sac growth. The one year-

survival rate was lower (79% vs 91%) in the presence of an endoleak, but no difference was observed in long term survival. The only predictor of endoleak persistence was massive neck calcifications [4].

In a single-centre retrospective study, F. Bastos Gonçalves et al. analysed 15 patients with primary E1A. On the first postoperative computed tomography angiography (CTA), one week after EVAR, seven endoleaks persisted and, at five months, all endoleaks had resolved spontaneously. One patient experienced aneurysm rupture two days after EVAR and was the only AAA-related death. At five years, one endoleak (6.6%) recurred and was associated with sac enlargement [6].

Qazi et al. performed a retrospective review including 337 patients who underwent EVAR. Of these, 24 had a E1A on completion angiogram. At the end of the FU, 22 (91.7%) resolved spontaneously. The median FU was 2.5 years, however the two persistent endoleaks had a FU of four and six years. Patient one with persistent endoleak experienced a reduction of the aneurysm size, unlike patient two, in which the diameter increased (5.66 cm to 5.8 cm) over 1.12 years and needed a graft extension [7].

Despite the recent data on conservative approach, most E1A are still treated with endovascular techniques. Among them we have Palmaz Stents, EndoAnchors, coils, cuffs and, when there is the need to create a new neck above the renal arteries, fenestrated devices and chimneys are the alternatives.

Proximal Cuffs

Proximal cuffs are especially useful when the stent graft is undersized or maldeployed and there is enough proximal neck length to deploy the graft [8]. Proximal cuffs are subdivided in standard proximal cuffs and fenestrated proximal cuffs (FEVAR). Fenestrated cuffs are mostly used when there is not enough space for the standard ones

and are customized for each patient and allow the extension of the proximal sealing zone to a healthier segment of the aorta [9, 10].

In a retrospective study, Rajani and his team [8] included 72 patients with an intraoperatively diagnosed E1A and divided them in two groups: 45 were treated with a proximal cuff, 24 underwent placement of a Palmaz stent and three patients required both techniques. All patients left the room with no endoleak, having a technical success of 100%. Recurrence of endoleak in the group treated with proximal cuffs was 6.7% (3/45) at 3, 12 and 60 months. These endoleaks were then successfully sealed with the Palmaz stent, staged hybrid repair or graft explant with open conversion. The median FU time of the cuff group was 755 days (approximately 25 months). No deaths were reported in any group.

Falkensammer et al. [9] analyzed the outcomes of 94 patients treated with the Anaconda Fenestrated device. Seven of these patients were treated for E1A after EVAR with a mean of 3.0 ± 0.9 fenestrations each. The technical success rate, defined as a successful access to the arterial system, a successful deployment of the endoluminal graft, the absence of type I and III endoleaks and a patent endoluminal graft without significant twist, kinks or obstruction in the first 24 hours was over 90% (91.7%). There was no intra-operative or in-hospital mortality. During FU (10 ± 9.5 months) no endoleak recurrence was reported.

In a retrospective single-center cohort study, Wang and his team [10] described the outcomes of the Zenith Fenestrated device used to rescue previous aortic repairs complicated with E1A or aneurysmal degeneration of the proximal neck. The study included a total of 12 patients, with six of them having a E1A and 14 target vessels. Technical success, defined as exclusion of the endoleak on completion angiogram and

successful stenting of all target fenestrations, was 100%. No deaths, endoleak recurrence or reinterventions were reported during the FU time of 21.2 ± 17.2 months.

ChEVAR

Focusing on ChEVAR, multiple studies demonstrate the safety and effectiveness of this technique over open conversion [3, 11].

Ronchey et al. [3] reported 39 patients whose E1A were treated with ChEVAR procedure, as they were considered to have high risk for open surgery. Technical success was attained in 90% (35/39) of the patients and was defined as successful main and parallel graft deployment at the intended site, patency of the chimney grafts (CGs) and absence of the endoleak on the last CTA, which was performed, on average, 21.9 months after the procedure. The complications of the four patients without technical success were as follows: three (8%) with persistent E1A and one (3%) with CG occlusion. The 30-day mortality was 2.6%. At 36 months, 66/70 (94.3%) of the CGs were patent. The greatest sac diameters shrank from 71.5 ± 29.0 mm to 69.9 ± 27.5 mm, increasing the neck length from 3.9±4.0mm to 20.4±4.2mm. No early or late procedure-related deaths were reported, but one patient died from acute cardiac failure and two from pneumonia.

In 2015, Montelione et al. [11] described 24 patients with endoleaks after EVAR, 23 with E1A and one with type IB endoleak and landing zones that precluded standard endovascular techniques. Endoleak sealing was 96% (23/24), one patient maintained a E1A in the postoperative CTA and was then successfully sealed with a proximal extension and Onyx embolization. One patient died after a superior mesenteric artery occlusion. The median FU was 23±28 months and during this period three patients died of unrelated causes. Furthermore, six reinterventions were performed: two for graft

occlusions and four related with E1A consisting in infrarenal neck banding, embolization with Onyx and proximal cuff extension with superior mesenteric artery stenting.

Embolization

Embolization is reserved for when more traditional techniques fail to seal the endoleak. This approach is particularly important in patients requiring urgent treatment, such as ruptured endoleaks, and patients with severe comorbidities or hostile neck or access vessels anatomy [12, 13].

This procedure requires a percutaneous access, the insertion of a microcatheter and the slow infusion of an agent into the aneurysm sac. The most common agents are N-Butyl Cyanoacrylate, ethylene vinyl alcohol copolymer (EVOH) and coils [14].

The effectiveness of EVOH was analyzed in a retrospective chart review by Assaf Graif et al. [13] that included six patients with E1A and two with type IB endoleak that were poor candidates for conventional approaches, because of complex aortic neck anatomy, exuberant calcification or medical comorbidities. All endoleaks were treated with endovascular EVOH and, in four of the E1A, coils were also necessary. Considering only E1A, immediate success was achieved in five out of six patients. The mean FU time was 6.9 months and one patient demonstrated a recurrent endoleak one month after the embolization. All the other five patients did not exhibit endoleak recurrence or meaningful sac growth.

Another retrospective study by Marcelin et al. was published with the objective to determine the safety and technical success of the same system in a retrospective study [15]. These investigators followed nine consecutive patients that developed a E1A after EVAR and were consequently treated using EVOH and coils. The primary endpoint was elimination of the endoleak and was achieved in six of the nine patients (67%). In one

patient, a collateral vessel and one of two gutters remained perfused. In the other two patients, one of the two gutters was not embolized. However, when we consider exclusively the endoleaks involving only one gutter, four out of four patients attained technical success. When considering two gutters, the primary technical success was only 40% (2/5). The mean FU time was 16 months. During this period, only one aneurysm increased by 14 mm. This same patient was the only that needed a secondary embolization 12 months later. Therefore, primary clinical efficacy was 89% (8/9) and secondary clinical efficacy was 100% (9/9).

JJ Harvey and his team analyzed the effectiveness of N-Butyl Cyanoacrylate [14] in three patients experiencing a E1A after EVAS. This system is thought to have some advantages over EVOH, including the possibility to use normal microcatheters and no need for dimethylsulfoxide catheter loading. During the early FU time, no endoleak, sac growth or complications were reported. The mean FU time after reintervention was 10.3 months (range 7-13 months).

Several authors have alerted for the possible complications of embolization. Among them, nontargeted embolization via communicating branches like lumbar and inferior mesenteric arteries [13, 14] and difficulty in detecting future recurrent endoleaks due to imaging artefacts [13].

EndoAnchors

Besides the more traditional techniques, such as ChEVAR or FEVAR, EndoAnchors may be another option for E1A in patients with hostile neck anatomy [16]. EndoAnchors are designed to penetrated both the endograft and the aortic wall, ensuring graft fixation and sealing during or after EVAR. This approach can be used to prevent

E1A, as well as to treat them when they are detected during the EVAR procedure or even after the primary procedure.

Vries et al. described two case reports using Endoanchors [18], a 79 and 78-year-old men who underwent EVAR for an AAA. These patients developed an E1A three and ten years later, respectively. Reintervention was required and an EndoAnchor was used to fix the primary device and the new cuff. Neither of the patients demonstrated an endoleak or any other complication on the completion angiogram and the six-month CTA.

This approach was also analyzed in a prospective study that included four European centers and 46 patients with AAA and a hostile neck anatomy [16]. The patients were divided in two groups: Group A was the therapeutic group and included 22 patients with intraoperative E1A and Group B was the preventive group and included 24 patients with no endoleak during the EVAR. In both groups EndoAnchors were implanted, in a therapeutic or a preventive approach, respectively. The mean FU period was 15 ± 12.9 months.

In group A, of the 22 intraoperative E1A, 13 (59.1%) were treated immediately after EndoAnchors deployment. The other nine (40.9%) patients had a persistent E1A. Five of these resolved during the first postoperative month. Therefore, the freedom from E1A at first month was 81.8%. At the 12-month CTA, the last four endoleaks were sealed, making it 100%. In group B, none of the patients showed E1A intraoperatively or postoperatively during the entire FU period. Initial overall AAA sac diameter was 58.0 ± 8.9 mm and decreased to 54.8 ± 9.4 mm according to the last available CTA. This difference was statistically significant in both groups with $n = 0.045$ in group A and $n < 0.001$ in group B ($p < 0.05$).

Two patients from group A died during FU. One died during the seventh month of FU due to an unknown reason but with no endoleak in his last CTA while the other

patient died 12 months after the procedure due to a previously unknown pulmonary oncologic condition. No deaths from group B were reported. Overall survival was 91%.

In another study, van Noort and her team included 54 patients that were treated with EndoAnchors for intraoperative (40 patients) or late (14 patients) E1A [17]. Overall, EndoAnchor penetration on the first post-procedure CTA scan was good in 187 (51.9%), borderline in 69 (19.2%) and missing in 104 (28.9%). From the 40 patients with intraoperative E1A, 36 (67%) had no E1A on both the first and last post-procedure CTA. At the first CT scan after EndoAchor deployment, 18 (33%) patients had an E1A and six resolved over time with no further treatment. The 12 patients with persistent endoleak were followed during a median of 8.5 months, while the FU time of the other six with resolved endoleaks was 32 months. From the 12 remaining endoleaks, four were treated with additional reinterventions. One was solved with an aortic extender cuff and additional EndoAnchors 2.1 months after the initial procedure. Another patient was treated with coil embolization six months after the initial procedure. In the third patient, the endoleak was sealed with five additional EndoAnchors 23.5 months after the initial EndoAnchor placement. Finally, open conversion was necessary to treat another endoleak 25.6 months later, after a failed additional procedure with ten EndoAnchors. In the remaining eight patients no reinterventions were performed to resolve the persistent E1A. At the end of the FU, eight of the 54 patients (14.8%) had a persistent E1A, despite three needed other techniques, such as extender cuffs, coil embolization and open conversion.

EVAS and ChEVAS

Another possible approach for E1A after EVAR is the Nellix Endovascular Aneurysm Sealing [5], associated (ChEVAS) or not with CG. This option is usually considered when the patient's anatomy is not suitable for other procedures [5, 18].

In a study performed by Youssef et al. [18], 15 patients underwent EVAS or ChEVAS procedures after EVAR complications. In ten of these patients, the complication was an E1A. The median FU was eight months (range 3-24). During this time, no additional intervention was needed, all the persistent endoleaks remained successfully sealed and chimney patency was maintained. The sac diameter decreased in all patients. An iatrogenic renal artery injury with active bleeding that needed a nephrectomy was the only intraoperative major complication. Two other patients had transient renal impairments that recovered before discharge. The mortality rate was 6.6% as one patient died two months after the procedure, with multiple organ failure due to a ruptured aneurysm and a preexisting chronic obstructive pulmonary disease. No late aneurysm--related deaths occurred.

Based on a prospectively EVAS database, Paraskevas et al. [5] analyzed ten patients that underwent EVAS or ChEVAS for post-EVAR complications, six of them E1A. All patients with E1A had 100% technical success in excluding the endoleak and no peri-operative or aneurysm-related fatalities were reported. Only one E1A recurred during FU (range 2-28) at the two-year scan due to disease progression at the visceral aorta. One patient with E1A died from bladder cancer.

In a recent study, Lareyre et al. [19] included ten consecutive patients that developed endoleaks after their EVAR procedure, five of these were E1A, and were treated with elective EVAS. The technical success, defined as successful sealing of the endograft with visceral vessel patency on intraoperative CTA, was 100% and no aneurysm-related death was reported. There was a need to deploy CG in four patients during the procedure. No graft thrombosis or CG occlusion were reported. The median FU period was 13.5 months (range 6.3-25.5).

Discussion

The development of E1A represents a marker of sealing failure after EVAR, occurring in up to 10% of EVAR procedures. Several techniques have been described, but there is little evidence favoring one over the others.

Many of the approaches described can be used both in E1A prevention and correction with emphasis for ChEVAR, EVAS/ChEVAS, FEVAR and EndoAnchors.

Comparing the rates of endoleak sealing after the endovascular procedure, the most effective technique is EVAS with or without CG with technical success achieved in all 21 patients [5, 18, 19]. Then, ChEVAR with a rate of endoleak sealing between 96-100% in 63 patients [3, 11]. Proximal cuffs with endoleak sealing rates around 71-100% in 58 patients [8-10]. Next, the embolization technique was evaluated in 18 patients and revealed E1A sealing rates varying from 66.7 and 100% [13-15]. Finally, with the lower endoleak sealing rates, EndoAnchors ranging between 59-100% performed in 78 patients [16, 17, 20].

In terms of reintervention, there were not significant differences between the different techniques. The lower reintervention rates were seen with EndoAnchors: between 0-7.4% during a FU of 2-32 months [16, 17, 20]. Proximal cuffs had reintervention rates ranging from 6.7-25% with a FU of 0.5-38.1 [8-10], CHEVAR ranged from 2.6-25% during the 0.23-71.3 months [3, 11], embolization from 0-33% during a FU of 3-35 months [13-15] and EVAS/ChEVAS from 0-20% with a FU time of 2-29 months [5, 18, 19].

Considering the freedom from endoleak at the end of FU time, either with or without additional interventions, it was achieved in 100% of the patients treated with proximal cuffs [8-10] and ChEVAR [3, 11] with a FU of 0.5-38.1 and 0.23-71.3 months, respectively. Next, with rates ranging 84-100% EVAS/ChEVAS [5, 18, 19] and

EndoAnchors [16, 17, 20] have also performed efficiently within similar FU times around 2-30 months. With slightly lower rates of endoleak freedom (78-100%), we have embolization at the end of the FU time between 3-35 months [13-15].

Considering the overall mortality, the lower rates were found in patients treated with EndoAnchors and ranged from 0-9% [16, 17, 20]. All the other techniques had similar overall mortality, around 0-25%.

Proximal cuffs, either standard or FEVAR, are one of the most common endovascular procedures for E1A sealing, particularly when the stent is undersized. They allow the extension of the proximal landing zone, excluding the aneurysm sac from circulation [21]. Although FEVAR after EVAR failure remains challenging, no perioperative incidents of major morbidity or mortality were reported when using FEVAR as a treatment of E1A [9, 10].

An advantage of ChEVAR is the possibility for further reintervention with proximal extension and gutter embolization if endoleak recurrence is detected. However, ChEVAR has some problems, including main graft oversizing, use of multiple stent-grafts and parallel graft combinations [11].

Comparing FEVAR with ChEVAR, the last is less expensive and does not require customization, which means it can be used in urgent/emergent situations [3, 22]. Nonetheless, the development of E1A is higher with ChEVAR than with FEVAR. In a study by Sörelius and his team, in juxtarenal AAA the incidence of postoperative E1A was 3.7% after FEVAR and 7.6% after ChEVAR [23].

Embolization with EVOH is not recommended as the final treatment of large endoleaks, since in these cases it has been associated with higher rates of failure and early recurrence [13]. On the other hand, embolization with N-Butyl Cyanoacrylate has a steep

learning curve [14]. Further investigation is needed to clarify which agent is the best option.

EndoAnchoring is especially useful in patients with hostile neck anatomy, in which other techniques are not suitable. Analyzing EndoAnchor, the authors emphasize the high rate of technical success adding only 15 to 20 minutes to the standard EVAR procedure [16]. Van Noort highlights the importance of effectively delivering EndoAnchor implants through the aortic wall, even though there was no evidence of clinical consequences of borderline or nonpenetrating EndoAnchors [17]. The main limitation of Valdivia's study was the heterogeneity of the FU times in the included centers, pointing out that the therapeutic group had the longest FU [16]. On the other hand, Van Noort and Vries' studies were limited by the small cohort and the short FU time [17, 20].

EVAS was thought for AAA repair to prevent endoleaks and stent graft migration. Since it seals the aneurysm sac instead of excluding it with proximal and distal fixation, it was initially believed to have less complications. The long-term outcomes are still under investigation, but some studies alerted for higher rates of endoleaks than expected, device movement and aneurysm enlargement [24]. EVAS is an option for E1A, especially when patients' anatomy precludes other techniques [18]. EVAS has the advantage of efficiently sealing the aneurysm and endoleaks thanks to the polymer endobags. Besides, no costume made material is required. The combination of EVAS with CG (ChEVAS) allows the filling of the spaces between the parallel grafts with endobags, preventing the development of gutters. There is, however, a steep learning curve for these approaches. Furthermore, it requires pressure monitoring and the prefill of the endobags in order to avoid endobag rupture or protrusion.

Overall, these techniques have shown good short and mid-term outcomes and seem feasible and safe endovascular solutions for E1A. At this point, a close FU is mandatory in patients treated with these endovascular techniques.

CONCLUSION

E1A is one of the most feared complications as it can lead to aneurysm sac growth, rupture and, ultimately, death.

From the available literature, several options are available including a conservative approach. Most of them have showed promising results. Endovascular aneurysm sealing with or without chimney has the highest primary technical success, with endoleak sealing rates up to 100%. Freedom from endoleak at the end of FU time was higher with proximal cuffs and ChEVAR.

Despite this, most of the available literature consists of small-scale studies. Further research is needed to understand which are the best therapeutic options, including randomized control trials.

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NOTES

Conflicts of interest.

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.

Isabel Viana: design and conception of the manuscript; writing the article; final approval of the manuscript;

Leandro Nóbrega: design and conception of the manuscript; writing the article; final approval of the manuscript;

José Oliveira-Pinto: design and conception of the manuscript; writing the article; final approval of the manuscript;

Armando Mansilha: design and conception of the manuscript; final approval of the manuscript.

TABLES

Table 1 Characteristics of the studies included for the association between the techniques and endoleak sealing

	CONSERVATIVE TREATMENT [4, 6, 7]	PROXIMAL CUFFS [8-10]	CHEVAR [3, 11]	EMBOLIZATION [13-15]	ENDOANCHORS [16, 17, 20]	EVAS AND CHEVAS [5, 18, 19]
NUMBER OF PATIENTS	43 [4] 15 [6] 24 [7]	45 [8] 7 [9] 6 [10]	39 [3] 24 [11]	6 [13] 9 [15] 3 [14]	2 [20] 22 [16] 54 [17]	10 [18] 6 [5] 5 [19]
	82	**58**	**63**	**18**	**78**	**21**
ENDOLEAK SEALING AFTER THE PROCEDURE	---	100% [8] 71.4% [9] 100% [10]	100% [3] 96% [11]	83.3 % [13] 66.7 % [15] 100% [14]	100% [20] 59.1% [16] 67% [17]	100% [18] 100% [5] 100% [19]
		71.4 – 100%	**96 – 100%**	**66.7 – 100%**	**59.1 – 100%**	**100%**

Table 2 Characteristics of the studies included for the association between the techniques, freedom from endoleak at the end of FU and reintervention rates

	CONSERVATIVE TREATMENT [4, 6, 7]	**PROXIMAL CUFFS [8-10]**	**CHEVAR [3]**	**EMBOLIZATION [13-15]**	**ENDOANCHORS [16, 17, 20]**	**EVAS AND CHEVAS [5, 18, 19]**
FOLLOW-UP	22-78 months [4] 0.58-5.52 years [6] 2,5; 4; 6 months [7]	755 days (25.1 months) [8] 10.1±7.7 months [9] 21.2 ± 17.2 months [10]	21.9 months (0.23–71.3) [3] 23±28 months [11]	6.9 months [13] 3—35 months [15] 7-13 months [14]	6 months [20] 15 ± 12.9 months [16] 13 months [17]	3-24 months [18] 2-29 months [5] 6.3-25.5 months [19]
	2.5 – 78 months	**0.5 – 38.4 months**	**0.23–71.3 months**	**3 – 35 months**	**2.1 – 32 months**	**2-29 months**
FREEDOM FROM ENDOLEAK AT THE END OF FU (WITH OR WITHOUT ADDITIONAL TREATMENT)	86.1% [4] 93.3% [6] 91.7% [7]	100% [8] 100% [10]	100% [3] 100% [11]	83.8% [13] 77.8% [15] 100% [14]	100% [20] 100% [16] 85.2% [17]	100% [18] 83.3% [5] 100% [19]
	86.1 – 93.3%	**100%**	**100%**	**77.8 – 100%**	**85.2 – 100%**	**83.3 – 100%**
REINTERVENTION DURING FU	11% [4] 6.7% [6] 4.2% [7]	25% [8] 6.7% [9] 11.7% [10]	2.6% [3] 25% [11]	33% [13] 11% [15] 0 [14]	0 [20] 0 [16] 7.4% [17]	0 [18] 0 [5] 20% [19]
	4.2-11%	**6.7-25%**	**2.6-25%**	**0-33%**	**0-7.4%**	**0-20%**

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ATTACHMENTS

1. Reporting guidelines
2. Publication guidelines in Journal Angiologia e Cirurgia Vascular

1. Reporting guidelines

Scale for the Assessment of Narrative Review Articles – SANRA

Please rate the quality of the narrative review article in question, using categories 0–2 on the following scale. For each aspect of quality, please choose the option which best fits your evaluation, using categories 0 and 2 freely to imply general low and high quality. These are not intended to imply the worst or best imaginable quality.

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2

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2

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The search strategy is not presented. — 0
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The literature search is described in detail, including search terms and inclusion criteria. — 2

2

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Key statements are not supported by references. — 0
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Key statements are supported by references. — 2

2

5) Scientific reasoning

(e.g., incorporation of appropriate evidence, such as RCTs in clinical medicine)

The article's point is not based on appropriate arguments. — 0
Appropriate evidence is introduced selectively. — 1
Appropriate evidence is generally present. — 2

2

6) Appropriate presentation of data

(e.g., absolute vs relative risk; effect sizes without confidence intervals)

Data are presented inadequately. — 0
Data are often not presented in the most appropriate way. — 1
Relevant outcome data are generally presented appropriately. — 2

2

Sumscore **12**

Fig. 1 SANRA - Scale

SANRA – explanations and instructions

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No manuscript references all statements. However, those that are essential for the arguments of the manuscript – "key statements" – should be backed by references in all or almost all cases. Exceptions could reasonably be made for rating purposes where a key statement has uncontroversial face-validity, such as "Diabetes is among the commonest causes of chronic morbidity worldwide."
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The item describes the quality of the scientific point made. A convincing narrative review presents evidence for key arguments. It should mention study design (randomized controlled trial, qualitative study, etc), and where available, levels of evidence.
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This item describes the correct presentation of data central to the article's argument. Which data are considered relevant varies from field to field. In some areas relevant data would be absolute rather than relative risks or clinical versus surrogate or intermediate endpoints. These outcomes must be presented correctly. For example, it is appropriate that effect sizes are accompanied by confidence intervals. Please rate how far the paper achieves this – thoroughgoingly (2), partially (1), or hardly at all (0). Unlike item 5, which relates to the use of evidence and of types of evidence in the manuscript's arguments, this item is concerned with the selection and presentation of concrete outcome data.

Fig. 2 SANRA—explanations and instructions document

Item 1 - Page 2: “Endoleaks represent one of the most common complications, which can be found in 20-50% of the cases [1, 2].” AND “The development of E1A can occur in more than 10% of EVARs [3, 4].”

Item 2 - Page 3: “Therefore, the aim of this paper is to review endovascular options for E1A repair.”

Item 3 - Page 4: “A literature search was performed on MEDLINE databases in order to collect studies regarding the management of type Ia endoleaks after EVAR. Articles from January 2010 until October 2020 were included.”

Item 4 - Page 2 and 5: “The development of E1A can occur in more than 10% of EVARs [3, 6].” AND “In fact, the endoleaks that fail to resolve in the operating room, show low rupture rates and aneurysm-related mortality and high spontaneous sealing rates [4, 6].”

Item 5 - Page 7 and 11: “In a retrospective single-center cohort study, Wang and his team [10] described the outcomes of the Zenith Fenestrated device used to rescue previous aortic repairs complicated with E1A or aneurysmal degeneration of the proximal neck.” AND “This approach was also analyzed in a prospective study that included four European centers and 46 patients with AAA and a hostile neck anatomy [16].” AND “This difference was statistically significant in both groups with $n = 0.045$ in group A and $n < 0.001$ in group B ($p < 0.05$).”

Item 6 - Page 15: “Embolization with EVOH is not recommended as the final treatment of large endoleaks, since in these cases it has been associated with higher rates of failure and early recurrence [13].”

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