DIMENSÃO DO SACO ANEURISMÁTICO COMO PREDITOR DE COMPLICAÇÕES APÓS O EVAR

IMPORTANCE OF AAA SIZE AS A PREDICTOR OF COMPLICATIONS AFTER EVAR

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RESUMO

Introdução: O EVAR corresponde atualmente ao principal método para correção de aneurismas da aorta abdominal. Contudo, a consciência acerca dos limites desta técnica revela-se essencial, para minimizar a ocorrência de complicações futuras. As características anatómicas do aneurisma constituem-se como os principais fatores de risco conhecidos para as complicações após EVAR. O diâmetro do saco aneurismático tem sido descrito como um fator de risco relevante para complicações futuras.
Os autores têm como objetivo rever a literatura disponível que analisa a associação entre o diâmetro aneurismático e o surgimento de complicações após EVAR.

Métodos: Bases de dados MEDLINE foram pesquisadas no sentido de identificar publicações que contemplassem informação específica sobre a relação do diâmetro do saco aneurismático e o surgimento de complicações após EVAR. Foram apenas considerados artigos em língua Inglesa entre os anos 2003 e 2019. O *endpoint* primário foi a ausência de eventos relacionados com o aneurisma.

Resultados: Cinco estudos foram incluídos no artigo, reportando resultados de 8443 doentes. Em dois dos estudos incluídos, é reportado um risco aumentado de complicações relacionadas com o aneurisma (HR 1.02 per mm de aumento do saco CI95% 1.01–1.04 e HR 1.8 95% CI, 1.20–2.72; P = .005). Dois estudos reportam um risco mais alto de rotura pós-implante e de conversão para cirurgia aberta em aneurismas com diâmetros superiores a 60mm. Por fim, um estudo reporta maior risco de complicações relacionadas com o colo em aneurismas com diâmetro > 65mm. [HR: 6.4 (2.3–17.7)].

Conclusão: O diâmetro do saco aneurismático representa um fator de risco relevante para complicações futuras. Contudo, não esta esclarecido se esta relação se deve a uma anatomia mais hostil em aneurismas maiores ou ao espaço livre de trombo dentro do saco. Uma correta e individualizada escolha da técnica assim como um seguimento imagiológico ajustado à anatomia pré-operatória é aconselhada neste subgrupo de doentes.

Palavras-chave
Correção endovascular de aneurisma da aorta abdominal; Saco aneurismático; Diâmetro; Resultado

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ABSTRACT

Introduction: *EVAR represents the preferred modality for Abdominal Aortic Aneurysms (AAA) repair. However, a comprehension regarding its limits is paramount to avoid future complications. AAA sac diameter has been described as a relevant risk factor for late complications. The purpose of this study is to summarize relevant findings regarding the association between AAA diameter and AAA-related complications.*

Methods: *MEDLINE databases were searched to identify data addressing specific information on the relation between AAA sac diameter and incidence of AAA-related complications. Only articles in English language between 2003 and 2019 was included. Primary endpoint was freedom from aneurysm-related complications.*

Results: *Five studies were included in our report, including 8443 patients. In two of the included studies patients with larger AAA sacs were at increased risk for aneurysm-related complications after EVAR (HR 1.02 per mm increase CI95% 1.01–1.04 and HR 1.8 95% CI, 1.20–2.72; P = .005). Two studies reported a higher risk of post implant ruptures (HR: 7.7 CI95% 3.1–18.7;) and late conversions (HR 1.6 CI 95% 1.1–2.3) in patients with AAA diameters over 6 and 6.5 cm, respectively. Finally, one study reported a higher rate of neck-related events in patients with AAA diameter > 65mm [HR: 6.4 (2.3–17.7)].*

Conclusion: *AAA diameter is a relevant risk factor for late complications. However, research is needed to clarify is these are attributable to the challenging associated anatomy or to the space free of thrombus within the sac. Judicious technique choice along with tailored follow-up strategies are advised in this subgroup of patients.*

Keywords

Endovascular Aneurysm repair; Aneurysm sac; Diameter; Outcome

INTRODUCTION

Endovascular aneurysm repair (EVAR) has become the preferred modality for Abdominal Aortic Aneurysm (AAA) repair. Still, a low but persistent risk of rupture and high rate of secondary interventions remain the main drawbacks and lifelong imaging surveillance is therefore mandatory.[1–3]

AAA diameter represents a significant risk factor for late complications as described in multiple series[4–8]*. However, in several reports larger AAA usually present with more hostile anatomies in proximal and distal seal sites as a consequence of anatomic distortion resultant from AAA growth. As such, it is not easy to isolate the effect of AAA sac per se as a predictor of complications. In addition, increasing AAA size has been shown to negatively affect the eligibility for EVAR.*[9,10]

The purpose of the current review is to summarize literature findings regarding the association between AAA sac size and the advent of future complications after EVAR.

METHODS

Pubmed databases were searched for relevant articles published between 2003 and May 2019. The key words "Aneurysm sac diameter", "AAA Lumen size", and "Complications after EVAR" were used in combination with the Boolean operators AND or OR. Only articles with follow-up data, longer than 30-day/in-hospital data, were included. Reports containing fewer than 10 patients were excluded. Primary endpoint was freedom from AAA-related complications. Secondary endpoints were overall and AAA-related survival.

RESULTS

Aneurysm-related complications

Diameter represents a risk factor for late complications[4,5,7–9]*. Peppelenbosch et al in 2004 (N=4392) described in the EUROSTAR population that larger aneurysm faced a higher risk of complications and also of AAA-related mortality. The authors have stratified the patients into three groups according to AAA diameter: Group A (4–5.4cm; N=1962), Group B (5.5–6.4cm; N=1528) and Group C (> 6.5cm; N=902). At baseline, group C had a greater percentage of severely angulated necks along with aneurysmal iliacs*[4]*. Regarding AAA-related complications, group C had a significantly higher rate of post-implant rupture: freedom from rupture after 4 years was observed in 97.2% of the entire group: 90.5% in group C, 98.3% in group B, and 98.3% in group A, P=0.001*[4]*. In line with the incidence of post-implant ruptured above described, incidence of type 1A and type 1B endoleak were also higher in the group with larger diameters.*

Accordingly, late conversions were also more frequent in the group C. In multivariable analysis, patients within the group C had a significant higher risk for late rupture (HR: 7.7 CI95% 3.1-18.7) as well as for late conversions (HR 1.6 CI 95% 1.1-2.3).[4]
Also with the EUROSTAR population, in patients undergoing EVAR with the Talent stent-graft, Waasdorp et al reported in 2005 (n=1317) that patients with AAA diameter > 60mm had greater incidence of post implant rupture and late conversions when compared to patients with diameters < 60 mm, over a median follow-up of 17 months. This study was methodologically different as 4 groups were formed according both to neck and AAA diameter: group A (neck < 26 mm and AAA< 60mm), group B (neck < 26 mm and AAA > 60 mm), group C (neck > 26 mm and AAAd< 60mm) and group D (neck > 26 mm and AAA> 60mm). When interpreting Kaplan Meier curves it is noticeable that group D has far lower freedom from rupture and conversions up to 5 years when compared to the remaining groups, however, freedom from rupture is lower in group B when compared to group C and A.[9]
In agreement with previous findings, Bastos-Gonçalves et al, described in 2014 that sac diameter represented an independent predictor of late complications after EVAR (HR 1.02 per mm increase CI95% 1.01-1.04).[8] *The same authors have stated in the population from the ENGAGE registry that AAA diameter > 65mm represented an independent predictor for neck events [HR: 6.4 (2.3-17.7)]*[7].
In 2017, Huang et al (N=874) focused attention on the impact of AAA diameter in the advent of late AAA-related complications. The authors divided patients into four groups according to sac diameter: group 1 < 5 cm, group 2 - 5.0-5.4 cm, group 3 - 5.5-5.9 cm and group 4 > 6 cm. Over a median follow-up period of 3.7 years, patients with larger diameters had greater risk for late complications after EVAR. In multivariable analysis, group 4 had 1.8-fold increased risk (95% CI, 1.2-2.72; P = 0.005) of complications compared with group 1. Similarly, compared with group 1, group 2 had 1.67-fold increased risk (95% CI, 1.02-2.76; P = 0.04) and group 4 had 1.87-fold increased risk (95% CI, 1.13-3.09; P = 0.01) of having a reintervention.[5]

Overall and AAA-related mortality

In 2004, Peppelenbosch and colleagues have reported higher AAA-related deaths in the group C (AAA> 6.5cm): freedom from aneurysm-related death at 5 years of 87.9%, 95.0%, and 97.0% in the three groups, respectively. These findings were also found in multivariable analysis: after adjusting for baseline characteristics group C had a significantly greater risk of AAA-related death (HR: 2.5 CI 95% 1.6-4.0). The same finding was observed regarding overall survival, however, statistical significance was only achieved when comparing group C with group A (4-5.4cm).[4]
Also Waasdorp et al described greater mortality for AAA groups > 60 mm, regardless of AAA neck diameter (approximately 73% survival in group D and 78% in group B compared to approximately 88% in group A, P=0.002).[9]
According to Huang et al, patient group status was significantly associated with survival: compared with group 1, a patient in group 3 had 1.47-fold higher risk (95% CI, 1.01-2.14; P = .04) and a patient in group 4 had 2.33-fold higher risk (95% CI, 1.64-3.32; P < .001) of having all-cause mortality.[5]

DISCUSSION

EVAR is now adopted as preferred AAA repair method. However, significantly higher reinterventions rates over time, raises concern regarding its durability[11]*. As such, it is paramount to perceive optimal candidates to EVAR, in order to avoid lifelong complications.*
AAA diameter has long been pointed as a significant risk factor for complications after EVAR. Most of this risk comes with the more hostile anatomy associated to larger aneurysms. Besides, as mentioned before, patients with larger AAA diameters usually have anatomies outside current standard EVAR devices instructions for use (IFU). Consequently, the ideal method of repair for patients with large AAA remains unknown and a matter of debate. Accordingly, personalized and judicious technique choice in the subgroup of patients is advised.
Several reports have addressed the potential risk associated to AAA diameter and conclusions remain quite unanimous. In 2003, Peppelenbosch et al described significantly higher rates of mid-term complications in patients with larger AAA diameters. Even though, more hostile anatomies were also reported in patients with larger diameters, these remained significant after multivariable analysis correcting for those differences.[4] *Also Waasdorp, found greater incidence of late rupture and conversions in groups with larger AAA diameter in the EUROSTAR population.*[9]
Later in 2014, Bastos-Gonçalves and colleagues also reinforced that AAA diameter independently increased the risk of AAA-related complications.[8] *The same authors have also analyzed predictors of neck-related complications in the population of the ENGAGE registry and have found that AAA diameter > 65mm represented an independent predictor for late proximal complications*[7].
Huang et al in a recent publications also pointed towards higher risk of complications and reinterventions in patients with larger AAA diameters.[5] *In this study, however, authors do not disclose proximal and distal sealing zones anatomies among referenced groups, which would probably be more hostile in patients with larger diameters.*

Both groups 3 and 4 (ie, those with larger aneurysms) had also greater risk of endoleak-related complications.
Despite the clear association between AAA diameter and complications after EVAR it not easy to isolate a single factor responsible for such difference. As previously mentioned, large AAA sacs have usually more hostile anatomies at the proximal and distal sealing sites and we consider this factor as crucial for these clinical findings. However, some reports have shown that AAA diameter represents an independent predictor for late complications, after correction for other anatomic features as demonstrated by Bastos-Gonçalves et al[7].
An alternative hypothesis could be that luminal volume (space within AAA sac free of thrombus) rather than AAA sac volume might actually play a more relevant role in the development of complications. Although no data is yet available, there may be an increased risk of stentgraft dislodgment due to the haemodynamic displacement forces caused by pulsatile flow, leading to disconnection, proximal migration or distal retraction with consequent seal complications. Contrarily, in patients with small lumens, the stent-graft remains imprisoned against the aortic thrombus, with less likelihood for subtle movements – Figure 1.

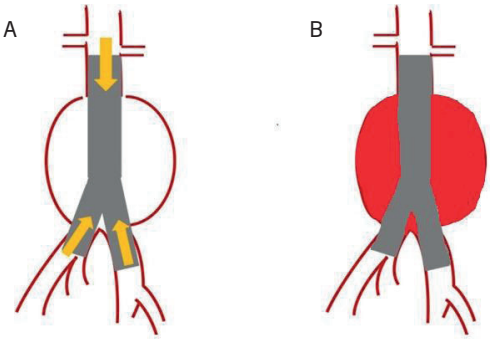

Figure 1 *Influence of luminal size on graft dislocations after EVAR.*

This figure illustrates the impact of thrombus-free lumen on sealing--related complications.

A – *No thrombus within the AAA sac increases the propensity for subtle graft movements and consequent loss of proximal and distal seal.*

B – *AAA sac filled with thrombus – graft remains imprisoned, without space for subtle movements.*

Aneurysm diameter represents a stage of aortic aneurysm disease progression. Consequently, a worse long-term survival might be anticipated in patients with larger AAA. Accordingly, higher AAA-related and overall mortality was reported in the abovementioned studies.[4,5,9]
This review has important limitations. Firstly, it is possible that not all available data was captured. Additionally, most are single-center reports with limited populations, making them susceptible of a publication bias.
In conclusion, AAA sac diameter represents an important risk factor for late complications as it distorts AAA anatomy and reduces eligibility to EVAR. As such, it's paramount to have a judicious technique choice in this subgroup of patients. In addition to anatomic distortion, it is likely that greater luminal spaces may conduct to sealing-related problems. However, more studies are needed to confirm such hypothesis.

ETHICAL RESPONSABILITIES

Protection of patients and animals:
The authors state that for this investigation no experiments were performed on humans and / or animals.

Confidentiality of the data:
The authors state that they have followed the centre's established protocols on the publication of patient data.

Right to privacy and informed consent:
The authors declare that no patient data is available in this article.

Conflict of interest:
The authors declare no potential conflict of interest.

REFERENCES

1. *De Bruin JL, Baas AF, Buth J, et al. Long-term outcome of open or endovascular repair of abdominal aortic aneurysm. The New England journal of medicine 2010;362:1881-9.*
2. *Patel R, Sweeting MJ, Powell JT, Greenhalgh RM. Endovascular versus open repair of abdominal aortic aneurysm in 15-years' follow-up of the UK endovascular aneurysm repair trial 1 (EVAR trial 1): a randomised controlled trial. Lancet (London, England) 2016;388:2366-74.*
3. *Nordon IM, Karthikesalingam A, Hinchliffe RJ, Holt PJ, Loftus IM, Thompson MM. Secondary interventions following endovascular aneurysm repair (EVAR) and the enduring value of graft surveillance. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 2010;39:547-54.*
4. *Peppelenbosch N, Buth J, Harris PL, van Marrewijk C, Fransen G. Diameter of abdominal aortic aneurysm and outcome of endovascular aneurysm repair: does size matter? A report from EUROSTAR. J Vasc Surg 2004;39:288-97.*
5. *Huang Y, Gloviczki P, Duncan AA, et al. Maximal aortic diameter affects outcome after endovascular repair of abdominal aortic aneurysms. J Vasc Surg 2017;65:1313-22.e4.*
6. *Baderkhan H, Goncalves FM, Oliveira NG, et al. Challenging Anatomy Predicts Mortality and Complications After Endovascular Treatment of Ruptured Abdominal Aortic Aneurysm. J Endovasc Ther 2016;23:919-27.*

7. *Bastos Goncalves F, Hoeks SE, Teijink JA, et al. Risk factors for proximal neck complications after endovascular aneurysm repair using the endurant stentgraft. European journal of vascular and endovascular surgery : the official journal of the European Society for Vascular Surgery 2015;49:156-62.*
8. *Bastos Goncalves F, Baderkhan H, Verhagen HJ, et al. Early sac shrinkage predicts a low risk of late complications after endovascular aortic aneurysm repair. The British journal of surgery 2014;101:802-10.*
9. *Waasdorp EJ, de Vries JP, Hobo R, Leurs LJ, Buth J, Moll FL. Aneurysm diameter and proximal aortic neck diameter influence clinical outcome of endovascular abdominal aortic repair: a 4-year EUROSTAR experience. Annals of vascular surgery 2005;19:755-61.*
10. *Sweet MP, Fillinger MF, Morrison TM, Abel D. The influence of gender and aortic aneurysm size on eligibility for endovascular abdominal aortic aneurysm repair. J Vasc Surg 2011;54:931-7.*
11. *Patel N, Bryant A, Duncan K, Kukreja P, Powell MF. Cost comparison of intrathecal morphine to intravenous patient-controlled analgesia for the first 24 h post cesarean delivery: a retrospective cohort study. J Anesth 2017;31:44-50.*