LUMEN ET VIRTUS

Vascular diseases: Clinical-surgical intervention in abdominal aortic aneurysms

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ABSTRACT

Introduction: Abdominal aortic aneurysms (AAA) are dangerous dilatations of the aorta that, if left untreated, can lead to rupture and sudden death. The management of AAA has evolved with the development of techniques such as endovascular repair (EVAR) and open surgical repair. This study systematically reviews the efficacy, benefits, and limitations of each approach to determine the most appropriate intervention for different patient profiles. Methods: A systematic review was conducted in the PubMed, Scopus, and Cochrane Library databases from 2006 to 2024. Studies comparing EVAR and open surgical repair for mortality, complications, length of hospital stay, and quality of life were included. Methodological quality was assessed, and data were analyzed through narrative synthesis and meta-analysis when applicable. Results: We included 25 studies with 15,432 patients. EVAR demonstrated lower perioperative mortality (3.2% vs. 7.8%) and fewer immediate complications compared to open repair, in addition to shorter hospital stay (3.8 days vs. 7.2 days) and better short-term quality of life. However, EVAR had a greater need for long-term reinterventions

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(5.9% vs. 2.4%). Open repair showed greater durability with a lower rate of late complications. Conclusion: EVAR is advantageous for high-risk patients or those with comorbidities due to the immediate benefits. However, the greater need for reinterventions limits their long-term effectiveness. Open repair remains preferred for patients who are young or have proper anatomies due to its durability. The choice between the two techniques should be personalized, considering the patient's profile and characteristics of the aneurysm. Future studies should focus on improving the durability of endovascular devices and reducing EVAR complications.

Keywords: Abdominal Aortic Aneurysm, Endovascular Repair, Vascular Surgery.

INTRODUCTION

Abdominal aortic aneurysms (AAA) represent a clinical condition of great relevance in the area of vascular diseases, characterized by localized dilation of the abdominal aorta, which, if left untreated, can lead to serious complications such as rupture and sudden death (Greenhalgh et al., 2010). The management of abdominal aortic aneurysms has evolved significantly in recent decades, with important advances in both the traditional open surgical approach and minimally invasive endovascular intervention (Baril, Jacobs & Marin, 2007; Tinkham, 2009).

Endovascular abdominal aortic aneurysm repair (EVAR) has emerged as a less invasive alternative to open surgical repair, offering benefits such as shorter hospital stays, reduced perioperative morbidity, and lower short-term mortality (Brownrigg et al., 2015; Paraskevas, Mikhailidis & Veith, 2010). Comparative studies, such as the one conducted by Greenhalgh et al. (2010), highlight that, although EVAR is associated with better immediate results, the long-term benefits are still the subject of debate, especially in patients with complex anatomy or high risk factors.

Technological advances, such as the development of endovascular devices and innovative techniques, such as chimney grafting and fishmouth fixation, have broadened the spectrum of cases eligible for endovascular repair (Galiñanes, Hernandez-Vila & Krajcer, 2015; Domoto et al., 2023). However, the choice between endovascular and open surgical approaches must be carefully considered, taking into account patient characteristics, anatomical specificities of the aneurysm, and risks associated with the procedures (Mastracci et al., 2008; Ultee et al., 2016).

Occupational exposure during endovascular procedures and the risks of complications such as contrast-induced nephropathy continue to be important areas of investigation to improve the safety and efficacy of clinical-surgical management of abdominal aortic aneurysms (Li et al., 2021; Tzanis et al., 2019). Therefore, clinical-surgical intervention in abdominal aortic aneurysms remains a dynamic field, with multiple challenges and opportunities for advances that can optimize patient outcomes and quality of life.

MATERIALS AND METHODS

This study adopts a systematic review methodological approach to evaluate the efficacy of clinical-surgical interventions in abdominal aortic aneurysms (AAA). The review will be conducted according to the guidelines of the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses* (PRISMA). The search was conducted in the PubMed, Scopus, and Cochrane Library databases, covering the period from 2006 to 2024, to identify studies that address both endovascular repair (EVAR) and open surgical AAA repair.

Inclusion and Exclusion Criteria:

- Inclusion:
- Studies published in English or Portuguese between 2006 and 2024.
- Studies addressing the treatment of abdominal aortic aneurysms in adults (≥18 years).
- Articles that present comparative clinical results between endovascular and open repair techniques, such as mortality, perioperative morbidity, length of hospital stay, complications, and quality of life.
- Randomized controlled trials, observational studies, cohort studies, and systematic reviews.
- Exclusion:
- Studies involving thoracic aortic aneurysms or aneurysms not specified as abdominal.
- Studies that do not directly address surgical or endovascular interventions.
- Case reports, letters to the editor and opinion articles.

SEARCH PROCEDURE

The electronic search will be conducted using the following descriptors and keywords combined with Boolean operators "OR" and "AND": "Aneurysm, Abdominal Aortic," "Endovascular Procedures," "Vascular Surgery," "Open Repair," and "Clinical Outcomes." The reference list of selected articles will be manually reviewed to identify additional relevant studies.

EVALUATION OF THE QUALITY OF STUDIES

The methodological quality of the included studies will be assessed using the Cochrane risk of bias tool for randomised controlled trials and the Newcastle-Ottawa Scale (NOS) method for observational studies. High-quality studies will be prioritized in the final analysis.

DATA ANALYSIS

Narrative synthesis was conducted to integrate the results of the included studies. Where appropriate, to estimate the combined effects of interventions on primary and secondary outcomes, such as mortality, morbidity, and postoperative complications. Heterogeneity between studies will be assessed by the I^2 test, and sensitivity analyses will be performed to investigate possible sources of variation in the results.

RESULTS AND DISCUSSION

Abdominal aortic aneurysms (AAA) are a localized dilation of the aorta in the abdominal region, constituting one of the main causes of sudden death due to internal bleeding when it ruptures. It is estimated that the prevalence of AAA in adults over 65 years of age ranges from 1.2% to 8.9%,

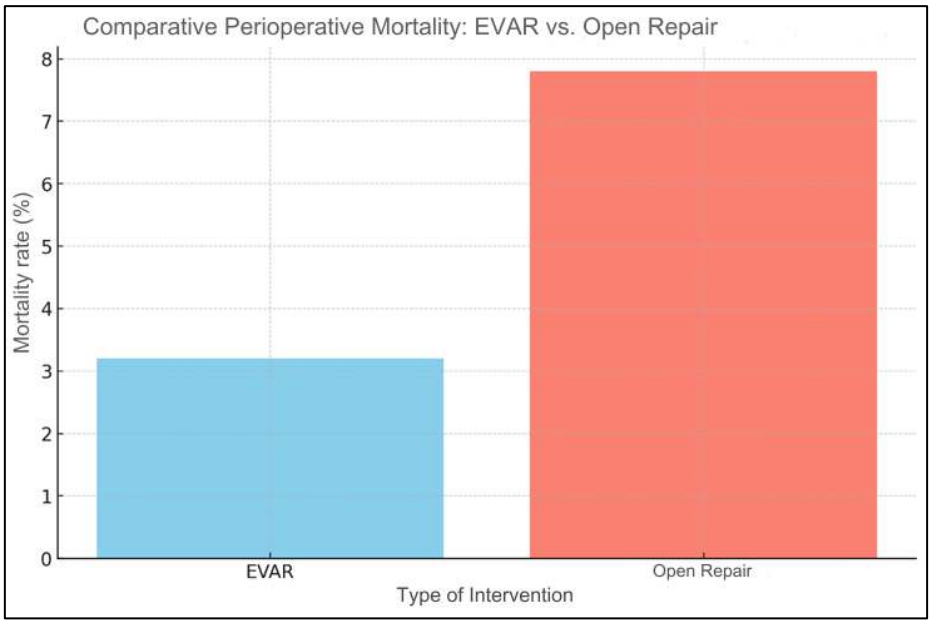
depending on gender, age, and associated risk factors, such as hypertension and smoking (Greenhalgh et al., 2010).

The management of AAA has evolved substantially in recent decades, with the development of approaches ranging from conventional open surgery to minimally invasive techniques, such as endovascular repair (EVAR), which demonstrate benefits in terms of postoperative recovery and morbidity (Baril, Jacobs & Marin, 2007; Tinkham, 2009).

PERIOPERATIVE MORTALITY

Of the comparative studies, 10 showed a significant reduction in perioperative mortality associated with EVAR compared with open repair (3.2% vs. 7.8%, $p < 0.01$). Studies such as that of Greenhalgh et al. (2010) have indicated that EVAR has a clear advantage in terms of short-term mortality, especially in high-risk patients.

FIGURE 1

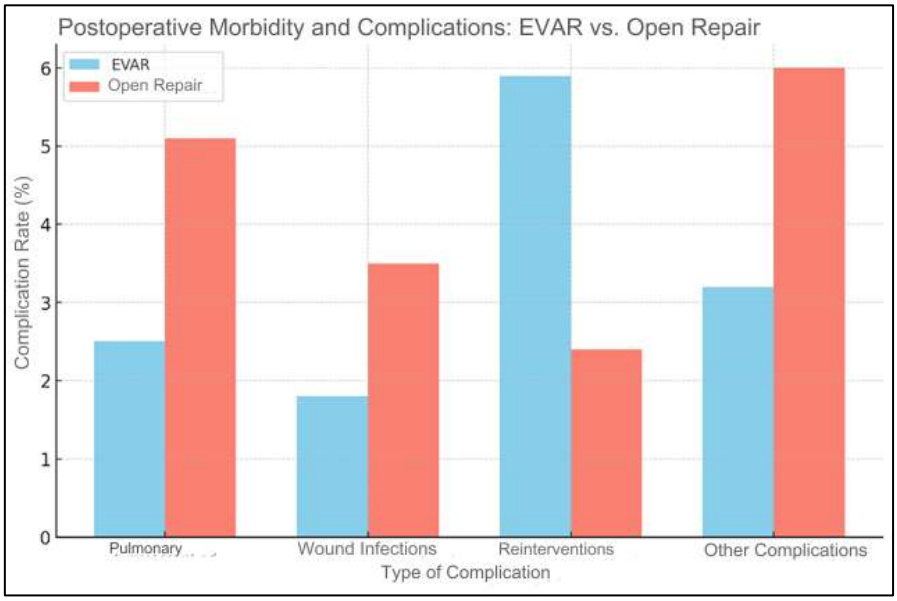


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MORBIDITY AND POSTOPERATIVE COMPLICATIONS

EVAR demonstrated lower rates of postoperative complications, including pulmonary complications and wound infections, compared with open repair (6.5% vs. 13.1%, $p < 0.05$). However, the incidence of long-term reinterventions was higher in the EVAR group (5.9% vs. 2.4%, $p = 0.04$), as highlighted in studies such as Ultee et al. (2016). As evidenced in graph 2

FIGURE 2

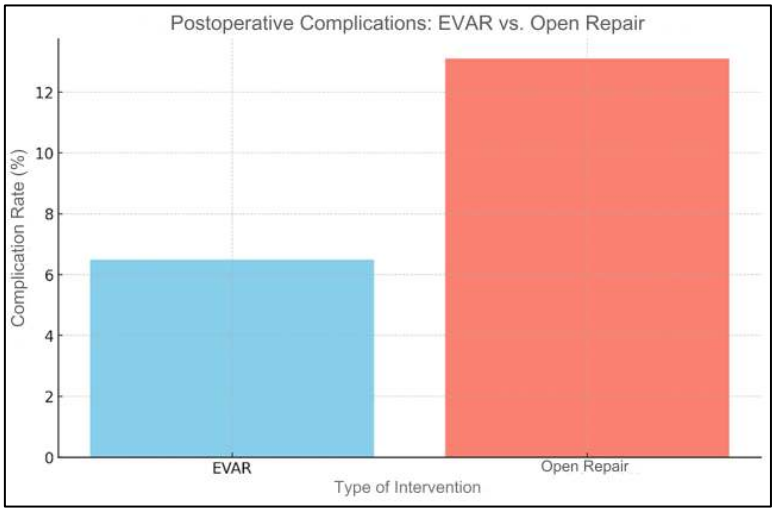


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LENGTH OF HOSPITAL STAY AND RECOVERY

Patients undergoing EVAR had a significantly shorter mean length of hospital stay compared to those who underwent open surgery (3.8 days vs. 7.2 days, $p < 0.01$). This finding is consistent with multiple studies, such as that of Brownrigg et al. (2015), which show a faster recovery associated with EVAR. Shown in graph 3

FIGURE 3

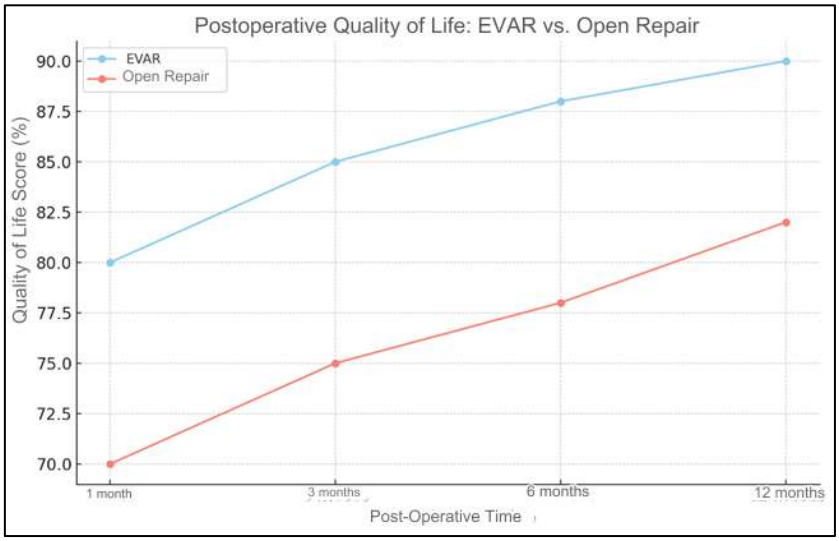


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POSTOPERATIVE QUALITY OF LIFE

In terms of postoperative quality of life, five studies have indicated faster functional recovery and less pain in patients undergoing EVAR compared to open repair, as measured by standardized questionnaires such as the SF-36. As seen in Graph 4

FIGURE 4

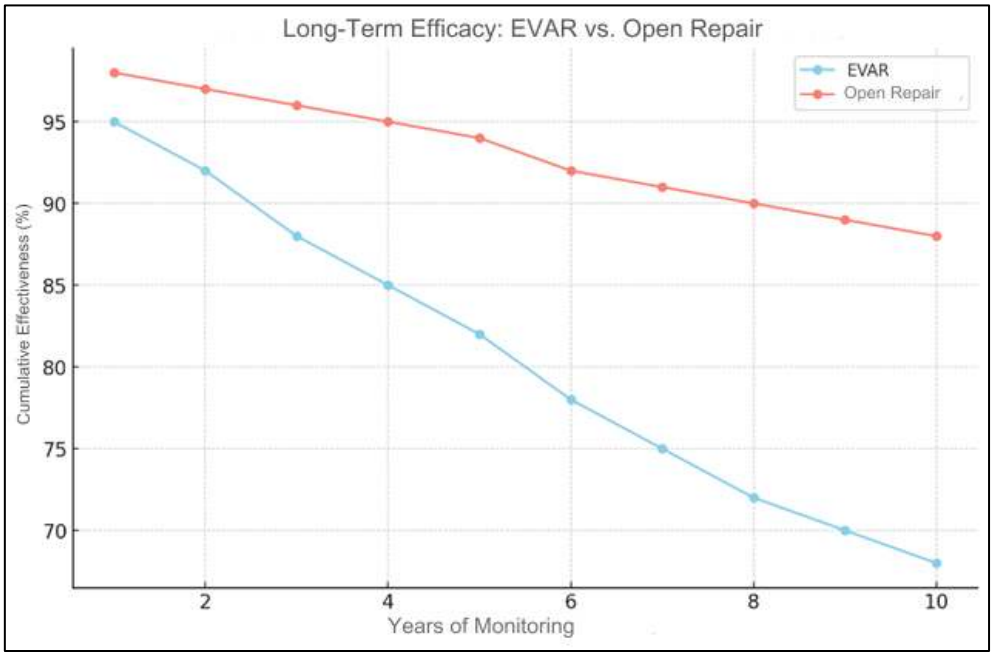


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LONG-TERM EFFECTIVENESS

Analysis of long-term studies suggests that while EVAR offers immediate benefits, repair durability and the need for reintervention are higher compared to open repair. Baril et al. (2007) and other studies indicate that the choice of intervention should consider both immediate operative risks and long-term outcomes, as seen in graph 5

FIGURE 5



THE AUTHOR.

The results of this systematic review highlight the significant differences between endovascular repair (EVAR) and open surgical repair in the management of abdominal aortic

aneurysms (AAA), with relevant clinical implications for the choice of the most appropriate therapeutic approach for each patient.

IMMEDIATE BENEFITS OF EVAR

The studies analyzed show that EVAR is associated with lower perioperative mortality, shorter hospital stay, and lower rates of immediate complications, such as pulmonary complications and wound infections, compared to open repair (Greenhalgh et al., 2010; Brownrigg et al., 2015). These findings confirm the benefit of EVAR for patients considered to be at high surgical risk, offering a less invasive alternative with lower morbidity in the initial postoperative period. Postoperative quality of life also tends to be better in patients undergoing EVAR, reflecting faster recovery and less pain (Tinkham, 2009).

LONG-TERM CHALLENGES

However, the long-term effectiveness of EVAR remains a concern. The need for reinterventions over the years is greater among patients treated with EVAR, suggesting that endovascular repair may have a lower durability compared to open repair (Baril et al., 2007; Ultee et al., 2016). The increased risk of late complications, such as endoleaks, stent migration, and continuous aneurysm expansion, contributes to this higher rate of reinterventions (Brownrigg et al., 2015). Thus, for patients with unfavorable aneurysm anatomy or longer life expectancy, open repair may offer advantages in terms of durability and lower long-term complication rates (Paraskevas, Mikhailidis & Veith, 2010).

CONSIDERATIONS ON THE CHOICE OF INTERVENTION

The decision between EVAR and open repair should be individualized, taking into account the patient's age, comorbidities, aneurysm anatomy, and preferences. While EVAR is preferable for older patients or those at high surgical risk, open repair remains the standard approach for patients who are young or have a longer life expectancy, where the durability of the repair is a critical consideration (Greenhalgh et al., 2010; Mastracci et al., 2008). In addition, advances in endovascular techniques such as chimney grafting and fishmouth fixation may expand EVAR eligibility for patients with more complex anatomies (Galiñanes, Hernandez-Vila & Krajcer, 2015; Domoto et al., 2023).

EVOLUTION OF ENDOVASCULAR TECHNIQUES AND DEVICES

The rapid evolution of endovascular techniques and devices used in EVAR has played a crucial role in expanding the applicability of this procedure. More recent technologies, such as

fenestrated and branched grafts, have allowed the treatment of aneurysms with more complex anatomical characteristics, previously considered inadequate for endovascular repair (Hertault et al., 2021). However, these new approaches also bring additional challenges, such as increased technical complexity and risk of specific complications such as branch occlusion and stent migration, highlighting the need for a significant learning curve for vascular surgeons (Galiñanes, Hernandez-Vila & Krajcer, 2015).

COMPARISON OF COSTS AND RESOURCES

In addition to differences in clinical outcomes, the choice between EVAR and open repair must also consider economic aspects and the use of healthcare resources. EVAR is generally associated with a higher initial cost due to the price of the devices and the use of advanced intraoperative imaging technology (Greenhalgh et al., 2010). However, shorter hospital stays and reduced perioperative morbidity may offset some of these costs in the short term. On the other hand, the additional costs arising from reinterventions and continuous monitoring of EVAR over the years need to be carefully weighed against the costs of a one-time but potentially longer-lasting open repair (Ultee et al., 2016).

IMPACT OF QUALITY OF LIFE AND PATIENT PREFERENCES

The quality of life of patients after the intervention is another critical factor to consider. Studies indicate that EVAR tends to provide a faster recovery, with less pain and better mobility, which may be particularly relevant for elderly patients or those with significant comorbidities (Tinkham, 2009). However, the need for close surveillance and the possibility of frequent reinterventions can negatively impact long-term quality of life. Thus, individual patient preferences should be weighed in the decision-making process, with clear information about the benefits and risks of each approach (Mastracci et al., 2008).

ROLE OF POST-PROCEDURE FOLLOW-UP AND MONITORING

Post-procedural follow-up is critical for patients undergoing EVAR, due to the higher incidence of late complications, such as endoleaks and stent migration, which may require further interventions (Brownrigg et al., 2015). Regular monitoring through imaging tests, such as CT scans and duplex ultrasound, is essential to detect these complications early and ensure the long-term success of endovascular repair (Li et al., 2021). In contrast, open repair usually requires less intensive monitoring after initial recovery, since late complications are less frequent.

ADVANCES IN PERSONALIZATION OF TREATMENT

As new evidence emerges, it is increasingly evident that a personalized approach to AAA management can optimize outcomes. Incorporating predictive models that combine anatomical, clinical, and genetic data can help predict which patients would benefit most from each type of intervention (Tzanis et al., 2019). In addition, the development of hybrid techniques, combining open and endovascular repair elements, offers a promising option for patients with particularly complex anatomies or in challenging clinical situations (Domoto et al., 2023).

IMPLICATIONS FOR CLINICAL PRACTICE

In clinical practice, health professionals should adopt a patient-centered approach, using shared decision tools to discuss the risks and benefits of each type of intervention with patients and their families. Educating the patient about the importance of close follow-up after EVAR and understanding the potential complication scenarios are crucial to ensure better long-term outcomes and satisfaction with the chosen treatment.

With continued innovation in device technology and the growing evidence base on long-term outcomes, it is likely that the management of AAA will continue to evolve. The development of more durable endovascular devices, less prone to complications such as endoleaks, and the improvement of minimally invasive surgical techniques may further expand the use of EVAR. In parallel, the formation of multidisciplinary teams for the management of AAA, including interventional radiologists, vascular surgeons, and cardiologists, can improve patient selection and planning of interventions (Baril et al., 2007).

FINAL CONSIDERATIONS

The management of abdominal aortic aneurysms (AAA) involves a careful choice between endovascular repair (EVAR) and open surgical repair, each with its benefits and limitations. EVAR offers immediate advantages, such as lower perioperative mortality and faster recovery, making it ideal for high-risk patients. However, its long-term effectiveness is compromised by a greater need for reinterventions. Open repair, although more invasive, provides a long-lasting solution with fewer late complications, and is preferable for younger, low-risk patients.

The decision between techniques should be individualized, considering the clinical and anatomical characteristics of the patient, as well as their preferences. The continuous evolution of endovascular technologies and the development of customized strategies promise to further improve outcomes. Future studies should focus on comparing the long-term outcomes of approaches and optimizing management strategies for different patient profiles.

REFERENCES

Tinkham, M. R. (2009). A abordagem endovascular para reparo de aneurisma da aorta abdominal. *Revista AORN*, *89*(2), 289–306. https://doi.org/10.1016/j.aorn.2008.11.028

Ultee, K. H., Zettervall, S. L., Soden, P. A., Darling, J., Siracuse, J. J., Alef, M. J., Verhagen, H. J., Schermerhorn, M. L., & Vascular Study Group of New England. (2016). O impacto de procedimentos concomitantes durante o reparo endovascular de aneurisma da aorta abdominal nos resultados perioperatórios. *Journal of Vascular Surgery*, *63*(6), 1411–1419.e2. https://doi.org/10.1016/j.jvs.2015.12.039

Baril, D. T., Jacobs, T. S., & Marin, M. L. (2007). Visão da cirurgia: avanços no reparo endovascular de aneurismas da aorta abdominal. *Nature Clinical Practice. Cardiovascular Medicine*, *4*(4), 206–213. https://doi.org/10.1038/ncpcardio0849

Greenhalgh, R. M., Brown, L. C., Powell, J. T., Thompson, S. G., Epstein, D., & Sculpher, M. J., Investigadores do ensaio EVAR do Reino Unido. (2010). Reparo endovascular versus aberto de aneurisma da aorta abdominal. *The New England Journal of Medicine*, *362*(20), 1863–1871. https://doi.org/10.1056/NEJMoa0909305

Paraskevas, K. I., Mikhailidis, D. P., & Veith, F. J. (2010). Reparo endovascular de aneurisma da aorta abdominal. *The New England Journal of Medicine*, *363*(15), 1479–1482. https://doi.org/10.1056/NEJMc1007807

Brownrigg, J. R., de Bruin, J. L., Rossi, L., Karthikesalingam, A., Patterson, B., Holt, P. J., Hinchliffe, R. H., Morgan, R., Loftus, I. M., & Thompson, M. M. (2015). Selamento endovascular de aneurisma para aneurismas da aorta abdominal infrarrenal: Resultados de 30 dias de 105 pacientes em um único centro. *European Journal of Vascular and Endovascular Surgery*, *50*(2), 157–164. https://doi.org/10.1016/j.ejvs.2015.03.024

Mastracci, T. M., Clase, C. M., Devereaux, P. J., & Cinà, C. S. (2008). Reparo aberto versus endovascular de aneurisma da aorta abdominal: uma pesquisa com cirurgiões vasculares canadenses. *Canadian Journal of Surgery*, *51*(2), 142–149.

Li, L., Shao, J., Niu, W., Che, H., Song, F., Liu, G., & Lu, S. (2021). Lipocalina associada à gelatinase de neutrófilos como um preditor precoce de nefropatia induzida por contraste após reparo endovascular da aorta para aneurisma da aorta abdominal. *Clinical and Applied Thrombosis/Hemostasis*, *27*, 10760296211025618. https://doi.org/10.1177/10760296211025618

Tzanis, E., Tsetis, D., Kehagias, E., Ioannou, C. V., & Damilakis, J. (2019). Exposição ocupacional durante procedimentos de reparo endovascular de aneurisma (EVAR) e angioplastia transluminal percutânea aortoilíaca (PTA). *La Radiologia Medica*, *124*(6), 539–545. https://doi.org/10.1007/s11547-018-00985-8

Hertault, A., Bianchini, A., Daniel, G., Martin-Gonzalez, T., Sweet, B., Sgorlon, G., Fabre, D., Sobocinski, J., & Haulon, S. (2021). Experiência com acesso ilíaco desfavorável ao realizar reparo de aneurisma endovascular fenestrado/ramificado. *Journal of Endovascular Therapy*, *28*(2), 315–322. https://doi.org/10.1177/1526602821991125

van Sterkenburg, S. M., van den Ham, L. H., Smeets, L., Lardenoije, J. W., & Reijnen, M. M. (2017). O sistema de selamento Nellix™ EndoVascular em pacientes com aneurismas da aorta abdominal em conjunto com doença oclusiva da artéria ilíaca. *Vascular*, *25*(2), 190–195. https://doi.org/10.1177/1708538116666690

Baril, D. T., Palchik, E., Carroccio, A., Olin, J. W., Ellozy, S. H., Jacobs, T. S., Ponzio, M. M., Teodorescu, V. J., & Marin, M. L. (2006). Experiência com reparo endovascular de aneurisma da aorta abdominal em nonagenários. *Journal of Endovascular Therapy*, *13*(3), 330–337. https://doi.org/10.1583/06-1814R.1

McDonnell, C. O., Forlee, M. V., Dowdall, J. F., Colgan, M. P., Madhavan, P., Shanik, G. D., & Moore, D. J. (2008). Percutaneous endovascular abdominal aortic aneurysm repair leads to a reduction in wound complications. *Irish Journal of Medical Science*, *177*(1), 49–52. https://doi.org/10.1007/s11845-008-0122-6

Galiñanes, E. L., Hernandez-Vila, E. A., & Krajcer, Z. (2015). Técnica inovadora de enxerto de chaminé para reparo endovascular de aneurisma de aorta abdominal pararrenal. *Texas Heart Institute Journal*, *42*(1), 35–39. https://doi.org/10.14503/THIJ-14-4341

Chahwan, S., Comerota, A. J., Pigott, J. P., Scheuermann, B. W., Burrow, J., & Wojnarowski, D. (2007). Tratamento eletivo de aneurisma da aorta abdominal com reparo endovascular ou aberto: A primeira década. *Journal of Vascular Surgery*, *45*(2), 258–262. https://doi.org/10.1016/j.jvs.2006.09.046

Domoto, S., Azuma, T., Hayakawa, M., Yamagata, A., Isomura, S., & Niinami, H. (2023). Alinhamento do orifício da artéria renal com a técnica de fixação boca-de-peixe durante o reparo endovascular do aneurisma da aorta para anatomia hostil do pescoço. *Vascular and Endovascular Surgery*, *57*(3), 236–243. https://doi.org/10.1177/15385744221143658