

Indications for antibiotic prophylaxis, and algorithms for dental management after open and endovascular surgery in patients with aortic diseases

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As the population of patients with aortic prostheses continues to grow, it becomes increasingly vital to implement comprehensive and rigorous protocols for antibiotic prophylaxis during dental procedures. That ensures strict adherence to the updated guidelines in order to effectively prevent the risk of life-threatening infections associated with vascular grafts and stent-grafts, thus safeguarding patient outcomes over the long term.

Introduction

Cardiovascular diseases (CVD) are the leading cause of death worldwide, including the rising incidence of aortic aneurysms.^{1,2} An aortic aneurysm is defined as a dilation of the aortic cross-section by more than 50% of its normal diameter. Abdominal aortic aneurysms (AAAs) affect 2–8% of patients in developed countries and are mostly asymptomatic, with a high mortality rate of approx. 80% if the aneurysm ruptures.³

Recent advancement in radiological preventive examinations (e.g., the Healthy Aorta Program in Poland), along with the development of surgical techniques, material science and endovascular procedures, have led to an increasing number of patients reporting to vascular departments for treatment.^{4,5} The two primary surgical approaches for treating AAAs are open aneurysm repair and endovascular aneurysm repair (EVAR). Both procedures involve the insertion of alloplastic material intended to restore or protect the pathologically altered segment of the aorta. Significant complications of such treatment are vascular graft or endograft infections (VGEIs), which can result from transient bacteremia related to various medical procedures, including dental procedures.^{6–10} Therefore, preoperative and postoperative dental consultations are essential to identify and eliminate potential odontogenic

sources of infection. Unfortunately, there is limited data regarding antibiotic prophylaxis in patients with vascular grafts or endografts.

The present study aims to provide practical recommendations for the management and prophylaxis of infections in patients with vascular prostheses, with a focus on dental care.

Methods

Purpose of the guidelines

Current European and American guidelines lack specific recommendations for antibiotic prophylaxis during dental procedures for patients with vascular prostheses. The existing preventive strategies are primarily based on guidelines for infectious endocarditis. To fill this gap, a multidisciplinary team of vascular surgeons, maxillofacial surgeons and dentists developed these guidelines to assist healthcare professionals in preventing infections in this high-risk group. The guidelines target dentists, maxillofacial surgeons and other providers involved in the care of patients with vascular grafts, including those with grafts in the supra-aortic trunks, thoracic or abdominal aorta. They aim to ensure effective prophylaxis against VGEIs during and after dental procedures.

Authors

These guidelines have been developed by a multidisciplinary team composed of experts in vascular surgery, maxillofacial surgery and dentistry. The collaborative effort ensures that the recommendations reflect a comprehensive and specialized approach to antibiotic prophylaxis in dental settings for patients with vascular prostheses, integrating expertise from multiple fields to address this specific clinical need.

Literature selection

The literature search for these guidelines utilized PubMed and Scopus, covering the period from January 2000 to December 2023. Studies were selected based on their peer-review status and relevance, following a hierarchy of evidence: systematic reviews and meta-analyses were prioritized, followed by randomized controlled trials (RCTs), observational studies and expert opinions.

Study protocol

These recommendations were prepared using the international Appraisal of Guidelines for Research and Evaluation (AGREE) Reporting Checklist (supplementary material, available from the corresponding author on reasonable request).

Recommendations

Management of the patient qualified for vascular treatment due to an aortic aneurysm

Before undergoing vascular treatment, it is essential for the patient to have a dental consultation that includes both a clinical examination and radiological diagnostics, such as a pantomographic X-ray or cone-beam computed tomography (CBCT). The patient must obtain a statement from a dentist, confirming the absence of odontogenic foci. It is important to emphasize that a clinical dental examination alone is not sufficient for a complete assessment; a thorough radiological evaluation is necessary for surgical qualification.

Management of the patient after aortic surgery

According to the guidelines of the European Society for Vascular Surgery (ESVS),¹⁰ and the Society for Vascular Surgery,¹¹ antibiotic prophylaxis in the dental office is currently recommended after both open repair surgery with alloplastic vascular prostheses and EVAR with a stent-graft. It is also recommended before any dental procedures involving the manipulation of the gingival or apical regions of the teeth, or the perforation of the oral mucosa, including scaling and root planing, and endodontic treatment.^{10,11}

The types of dental procedures with recommendations for antibiotic therapy in patients after vascular procedures are shown in Table 1. However, in the aforementioned guidelines, there are statements where antibiotic prophylaxis is required for certain dental procedures, but no information is provided about the type and exact dosage of antibiotics. Additionally, these guidelines are based on the American College of Cardiology/American Heart Association (ACC/AHA) guidelines for patients with endocarditis.¹²

Based on the previously published guidelines,^{10–13} recent literature on infectious endocarditis, VGEIs and oral bacterial flora,^{14–17} and clinical experience, the authors of this article have prepared recommendations regarding antibiotic prophylaxis for patients with vascular prostheses (Tables 2 and 3).

Discussion

With over 35 million pulsatile movements per year, the aorta presents a challenging environment for the implantation of vascular prostheses and stent-grafts, which must endure over time without complications, such as endoleaks, false aneurysms, or one of the most challenging

Table 1. Recommendations for antibiotic therapy in dental procedures in patients after the implantation of alloplastic material

Type of procedure	Diagnosis	Antibiotic prophylaxis	Dental procedures
Endovascular procedures	status after the endovascular treatment of an aortic aneurysm with a stent-graft	required	
Hybrid procedures	status after the treatment of the aorta with endovascular techniques and vascular prosthesis implantation	required	– root canal treatment – peripheral surgery (the resection of the tooth tips) – tooth extraction
	status after the treatment of the aorta, using an endovascular prosthesis and an extra-anatomical alloplastic bypass	required	– implant placement – periodontal surgery (including flap techniques, and supra-guminal and sub-guminal curettage)
Open surgery procedures	open surgical treatment with an alloplastic prosthesis	required	– scaling and root planing*
	status after any surgical procedures within the previously infected vascular prosthesis	required ** (not only antibiotic prophylaxis, but also postoperative antibiotic therapy)	

* The guidelines do not provide detailed information on supra-guminal and sub-guminal scaling; in this case, the possibility of interrupting the continuity of the mucous membrane is important.

** In the available literature, there is no specific data regarding patients who underwent interventions within the previously infected vascular prostheses. It is generally assumed that these patients are classified within the broader group of individuals with implanted vascular prostheses.

Table 2. List of dental procedures with the algorithms of the perioperative procedure and antibiotic therapy

Dental procedure	Antibiotic prophylaxis	Recommended additional procedures	Comments
Conservative treatment of the teeth	not recommended	–	–
Infiltrative/conduction anesthesia	not recommended	–	in non-infected tissues
	recommended	–	in infected tissues
Endodontic treatment	recommended	– dental dam – rinsing protocol – sealed temporary fillings	–
Periapical surgery	recommended	–	–
Scaling and root planing	recommended	–	–
Tooth extraction	recommended	–	–
Implant placement	recommended	–	there is no literature data on the safety of implant therapy in this patient population

Table 3. Antibiotic type and dosage in dental procedures with the recommended prophylaxis in patients with vascular prostheses

Patient group	Timing of prophylaxis	No allergy to penicillin		Allergy to penicillin	
		antibiotic	dosage	antibiotic	dosage
Adults	single dose 30–60 min before the procedure	amoxicillin	2 g p.o.	cephalexin	2 g p.o.
		ampicillin	2 g i.m. or i.v.	azithromycin or clarithromycin	500 mg p.o.
		cefazolin or ceftriaxone	1 g i.m. or i.v.	doxycycline	100 mg p.o.
		–	–	cefazolin or ceftriaxone	1 g i.m. or i.v.
Children	single dose 30–60 min before the procedure	amoxicillin	50 mg/kg p.o.	cephalexin	50 mg/kg p.o.
		ampicillin	50 mg/kg i.v. or i.m.	azithromycin or clarithromycin	15 mg/kg p.o.
		cefazolin or ceftriaxone	50 mg/kg i.v. or i.m.	doxycycline	<45 kg: 2.2 mg/kg p.o. >45 kg: 100 mg p.o.
		–	–	cefazolin or ceftriaxone	50 mg/kg i.v. or i.m.

p.o. – per os; i.v. – intravenously; i.m. – intramuscularly.

Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema or urticaria related to the use of penicillin.

complications, VGEIs. As the number of patients treated with aortic prostheses or stent-grafts continues to rise, particularly in an aging population, it is crucial to develop management algorithms for this patient group, especially in the dental office, to eliminate potential sources of infection.¹⁸

The etiology of prosthetic infections, including those caused by bacteria of dental origin, is complex and closely related to the unique microenvironment where the prostheses are implanted, namely the aorta and the aortic aneurysm itself. The aorta, being a large-diameter artery with wave-like variations in blood flow velocity, creates

challenging conditions for graft implantation. The material of the endograft is subjected to tension stress and constant pulsatile movements, which can cause micromovements. These micromovements may lead to the displacement of the stent-graft, resulting in blood leakage between the stent-graft and the vessel wall, or even the rupture of the endograft. Consequently, a reservoir of extravasated blood can form along the outer wall of the prosthesis/graft, which may serve as a breeding ground for bacteria, leading to the persistent superinfection of the vascular prosthesis.¹⁹

Abnormal epithelialization can lead to the exposure of alloplastic material within the aortic lumen, thereby increasing the risk of infection. Abnormalities in epithelialization within the graft are confirmed through the formation of a very thin layer of neointima and/or the segmental exposure of graft components, such as the wire elements of the crown, abutments and fragments of the covering material. The exposed covering material of the prosthesis and the stent-graft provides a potential site for bacterial accumulation.¹⁸

In the examinations of the explanted prostheses and stent-grafts, the bacterial contamination of the prosthesis wall was confirmed, particularly on the external side (aneurysm sac side). For the prostheses made of polytetrafluoroethylene (PTFE) and polyethylene terephthalate, bacterial presence was found in 84.3% and 94.7% of cases, respectively, as determined by electron microscopy.¹⁸

Recent studies indicate that up to 58% of VGEIs are attributed to Gram-positive bacteria, including *Staphylococcus aureus*, enterococci and coagulase-negative staphylococci. In the oral cavity, Gram-positive bacteria, predominantly streptococci, are most common. Therefore, β -lactams, including penicillins and cephalosporins, as well as macrolides, are recommended for the prevention of VGEIs. β -lactams should be considered the first-line treatment due to their efficacy against the predominant bacterial pathogens involved. Additionally, a single administration of antibiotics for prophylaxis provides coverage for approx. 4 h.^{10,20–25}

The radiological signs of prosthetic infection include the presence of fluid around the vascular prosthesis and gas bubbles in the tissue adjacent to the prosthesis or the aortic aneurysm sac in the case of EVAR, particularly when contamination involves anaerobic bacterial flora.²⁶

During a single procedure, the removal of the vascular prosthesis typically requires reconstruction with an extra-anatomical bypass or the use of the previously contaminated environment to restore blood flow distal to the operated area. This necessity increases the risk of subsequent infection. Additionally, patients initially deemed suitable for endovascular surgery often cannot be considered for open vascular prosthesis replacement due to their overall condition, comorbidities or medications.²⁷ As a result, the only remaining therapeutic options are chronic antibiotic therapy and the drainage of the periprosthetic abscess.

However, such treatment may have many adverse side effects and is often ineffective. Therefore, the importance of eliminating any risk factors for vascular prosthesis infection cannot be overstated.

Dental procedures are associated with transient bacteraemia. The guidelines from vascular surgery societies for managing aortic prostheses and stent-grafts emphasize the need for antibiotic prophylaxis in all dental procedures that involve the disruption of the oral mucosa and periapical surgery, including endodontic treatment, as well as scaling and root planing.

It is important to note that current vascular surgery guidelines do not provide specific recommendations regarding the optimal duration of antibiotic prophylaxis, nor do they explicitly address whether prophylaxis should be continued until the full epithelialization of the vascular prosthesis is achieved. This uncertainty may be partly attributed to the previously mentioned abnormal and often incomplete epithelialization of vascular grafts. In contrast, cardiological guidelines recommend a prophylactic period of 6 months. This discrepancy highlights a key difference between vascular and cardiological guidelines, owing to the previously discussed epithelialization issues associated with aortic prostheses.¹⁸

The European and American guidelines do not specify the exact doses of antibiotics to be used for dental prophylaxis.^{10,11,28} They only suggest the use of prophylaxis (recommendation level 1B), referencing practices from infectious endocarditis. The authors of this article based their recommendations on the general vascular surgery guidelines for antibiotic prophylaxis in dentistry related to infectious endocarditis, as well as on the Polish recommendations regarding antibiotic groups and the recommended doses from the National Antibiotic Program.¹³ However, given recent publications questioning the necessity of antibiotic prophylaxis for dental procedures in the context of infectious endocarditis,²⁹ it is crucial to continually monitor this topic and update guidelines in accordance with the latest evidence.

There is no contraindication to conservative dental treatment in patients with implanted prostheses or stent-grafts, provided that the oral mucosa is not compromised. The guidelines do not recommend antibiotic prophylaxis for the local anesthesia of non-infected tissues.³⁰

Endodontic treatment is essential for patients with vascular prostheses or stent-grafts, as these patients are at increased risk of infection due to potential bacteremia during procedures. Vascular surgery guidelines stress the importance of antibiotic prophylaxis to mitigate this risk, which arises from bacteria potentially entering the periapical area during canal preparation, whether manual or mechanical, and through the irrigating solutions or sealing materials extending beyond the apex.³¹ To reduce the risk of infection, endodontic treatment should adhere to rigorous protocols. Using a rubber dam is crucial for maintaining a sterile environment, and efforts should be

made to complete the treatment in a single session to limit exposure to pathogens. Additionally, the radiological assessment of the endodontically treated teeth is necessary to ensure treatment success and monitor for any complications.³¹

While endodontic treatment is generally preferred over extraction, the long-term prognosis of the tooth must be carefully evaluated. Teeth with extensive periapical lesions or questionable restorability are at high risk of becoming sources of chronic infection. If the long-term survival of the tooth is uncertain, its potential to harbor infection should be weighed, and the patient must be informed of the risk. The choice between endodontic treatment and extraction should be based on a comprehensive assessment of the condition of the tooth and the likelihood of a successful, infection-free outcome. If extraction is necessary, antibiotic prophylaxis is strongly recommended to prevent the introduction of pathogens into the bloodstream during the procedure.³¹

The decisions regarding modifications to antiplatelet or anticoagulant therapy must be made in close collaboration with a vascular surgeon to avoid compromising systemic health and increasing the risk of postoperative complications. Tokarek et al. noted a concerning trend where dentists independently modify or discontinue these therapies without proper consultations, potentially leading to adverse outcomes.³² Therefore, it is essential that dentists adhere strictly to the established guidelines and work closely with the patient's medical team to ensure the best possible treatment outcomes and minimize the risk of complications.³³

Patients with branched stent-grafts require special consideration. This innovative endovascular procedure involves reconstructing the aorta and its branches, necessitating the implantation of multiple vascular prostheses. Due to the novel nature of this procedure and the absence of specific guidelines for this patient group, extra caution is required during dental procedures. It is crucial to address any potential inflammatory foci that may arise after the implantation of a branched stent-graft, as infection could complicate the situation significantly, given the difficulty of replacing or removing the implanted prostheses.

Currently, researchers recommend antibiotic prophylaxis for all dental procedures that involve the disruption of the oral mucosa. If odontogenic inflammation is present, the source of infection should be addressed and antibiotic therapy should be extended by 3–5 days based on the patient's clinical condition. Additionally, close postoperative monitoring is essential, as potential sources of infection pose a direct risk of prosthesis infection, sepsis, and potentially, death.

In the opinion of the authors, prolonged postoperative antibiotic therapy is indicated in cases of complicated peritoneal inflammation, such as those with concomitant purulent exudation, massive inflammatory infiltration,

peritoneal abscess, or the infiltration of the surrounding soft tissues. This approach aims to limit the existing bacteremia and prevent the bacterial contamination of the vascular prosthesis; however, further studies are required to validate its effectiveness.

Qualification for implant procedures in patients with implanted vascular prostheses or stent-grafts should be always carefully considered by a dentist. Patients need to be informed about potential complications, including local inflammation immediately after surgery and the development of chronic inflammation in the implant area. While there are no available studies specifically addressing peri-implantitis in this patient group, various therapeutic options should be presented to the patient, including both fixed and removable prostheses. Currently, there are no clear guidelines for the treatment of this patient group, and this type of procedure is not specifically addressed within the guidelines of vascular surgery societies.

Patients who have been diagnosed and treated for a vascular prosthesis infection should be considered at particularly high risk.

While hygienization in the dental office is typically performed by qualified hygienists, eligibility for such procedures should be assessed by a dentist. This is crucial for this patient group. Scaling and root planing, in particular, is an indication for antibiotic prophylaxis, and this requirement must not be overlooked during patient preparation.³⁴

Nonetheless, an article by Özdemir Kabalak et al. underscores the fact that despite the realized need for antibiotic prophylaxis, barriers such as inconsistent adherence to guidelines, the lack of education and varying practices in dental settings continue to impede rational antibiotic use.³⁴ The effective management of these issues requires a standardized approach to prophylaxis and improved adherence to guidelines to minimize the risk of antibiotic resistance and optimize patient outcomes. Thus, the continuous monitoring and updating of guidelines in line with recent literature are essential to address the evolving challenges in dental care for patients with aortic prostheses and stent-grafts.

Strengths and limitations of the guidelines

The guidelines are strengthened by a comprehensive literature review from January 2000 to December 2023 across multiple reputable databases, ensuring an up-to-date evidence base. A hierarchical approach prioritizing systematic reviews, meta-analyses and RCTs adds reliability, while a multidisciplinary team brings diverse expertise to the recommendations. However, limitations include limited specific data on antibiotic prophylaxis for patients with vascular grafts or endografts in dental settings, leading to reliance on broader guidelines. Additionally, while the guidelines are built on the existing strategies for

infectious endocarditis, they may not fully address the unique needs of patients with vascular prostheses.

Conclusions

In conclusion, as the number of patients with vascular diseases, including aortic conditions, continues to grow, it is crucial to address the evolving needs of this population. Increased patient awareness regarding oral health will likely lead to a higher demand for dental procedures. Ensuring that these procedures are performed safely and in accordance with current standards is essential to prevent complications and maintain optimal outcomes. The guidelines provided emphasize the importance of tailored antibiotic prophylaxis, and highlight the need for ongoing research and updates to refine these strategies. Adhering to these recommendations will help manage the risk of infection effectively and enhance patient care in this high-risk group.

Potential resource implications

Implementing these comprehensive recommendations may increase demands for healthcare resources, as the emphasis on preoperative and postoperative dental consultations could lead to additional costs and time commitments, requiring better coordination between dental and vascular care teams. Enhanced antibiotic prophylaxis protocols might raise procedure costs and necessitate ongoing monitoring. Additionally, healthcare providers may need further training, potentially involving workshops or updated materials. While these preventive measures could reduce infections and improve outcomes, they may also impact overall healthcare resource utilization and costs. Integrating these guidelines into clinical workflows may require administrative adjustments and new protocols, making effective planning crucial to addressing these resource implications while aiming to enhance patient outcomes and prevent complications.

Update of the guidelines

To ensure the continuity and relevance of these guidelines, the authors emphasize the need for their inclusion in the forthcoming European as well as Polish recommendations for dental prophylaxis and antibiotic therapy.

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