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Folia Medica 65(5):788-799
DOI: 10.3897/folmed.65.e99682

Original Article

Infective Endocarditis: Prevention Strategy and Risk Factors in an Animal Model

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Received: 6 Jan 2023 ♦ **Accepted:** 22 Feb 2023 ♦ **Published:** 31 Oct 2023

Citation: Mitov G, Kilgenstein R, Partenheimer P, Ricart S, Ladage D. Infective endocarditis: prevention strategy and risk factors in an animal model. Folia Med (Plovdiv) 2023;65(5):788-799. doi: 10.3897/folmed.65.e99682.

Abstract

Introduction: Infective endocarditis is a serious infection of the endocardium, especially the heart valves, which is associated with a high mortality rate. It generally occurs in patients with altered and abnormal cardiac architecture combined with exposure to bacteria from trauma and other potentially high-risk activities with transient bacteremia.

Aim: The aim of the study was to develop a reproducible periodontitis-endocarditis model in a rat that can be used to answer the question of how the administration of antibiotic prophylaxis before tooth extraction affects the prevalence of bacteremia and the incidence of endocarditis.

Materials and methods: Thirty-five female Wistar rats were divided into three groups: periodontitis group (PG): ligatures were placed bilaterally on maxillary first molars, and the maxillary molars were extracted after 30 T; endocarditis group (EG): in addition to PG, aortic valve injury was performed with simulated prosthetic material before extraction; antibiotic prophylaxis group (AG): in addition to EG, a single-shot antibiotic administration was performed 30–60 minutes before extraction. Periodontal indices were collected, blood samples were microbiologically analyzed. Hearts were examined histologically after euthanasia.

Results: On the day of extraction, 93% of the ligatures were still in situ. The average approximal plaque index of maxillary first molars was 92%. The average papilla bleeding index according to Saxer and Mühlemann of the first molar in the first quadrant was grade 3, in the second quadrant – grade 2. The average probing depth of the first molar in the first quadrant was 3 mm, in the second – 2 mm. Endocarditic changes were identified in 20% in the AG group, 60% in the EG, and 0% in the PG control group. A successful model was developed by reliably developing endocarditis and periodontitis. Specific marker germs for periodontitis could be detected in blood cultures. The effectiveness of antibiotic prophylaxis prior to tooth extraction in groups at risk of endocarditis has been demonstrated in animal models.

Conclusions: In the present experimental animal study, a reproducible model could be developed by creating a manifest periodontal lesion, which, in connection with an aortic valve lesion and a tooth extraction, triggers bacteremia.

Clinical relevance

The model could act as a basis for further studies on the topic to answer remaining questions related to oral pathogens and IE.

Keywords

antibiotic prophylaxis, infective endocarditis, periodontitis, rat model

INTRODUCTION

Infective endocarditis (IE), an infection of the endocardium that can also involve the heart valves, is a rare but fatal disease. Despite improved techniques in surgical intervention and advances in antibacterial therapy, the mortality rate of this condition remains high (20%–30%).[1] The annual incidence in developed countries is 3 to 9 cases per 100000 people per year, with an average age of 36–69 years.[2,3] Congenital heart defects, prior IE, rheumatic heart disease, and prior valvular surgery pose a risk for IE.[4] The recent dramatic increase in implanted intracardiac material explains the increased incidence of IE today.[5] With a rise in the number of patients surviving into adulthood with congenital heart defects, the risk population for infective endocarditis grows.[6]

Invasive dental procedures are seen as a potential risk factor for IE. However, an association of both factors remains controversial. Procedures such as dental extractions, periodontal surgeries and scaling but also chewing of hard food can trigger temporary bacteremia. In this way, abnormal heart valves or damaged heart tissue can become infected. An association between invasive dental procedures and IE has been found in many studies[7-10], whereas other studies find no association or a very low risk[11,12].

Gingivitis and periodontitis are among the most common infections in humans. Gingivitis can develop within days and involves the inflammatory response of the gingiva, usually to dental biofilm. Periodontitis develops as a result of the interaction of chronic bacterial infection and the body's inflammatory response and results in irreversible destruction of the structures of the periodontium, up to and including the loss of the tooth. Periodontitis is usually caused by inadequate oral hygiene.[13]

In gingivitis and periodontitis, the dental and marginal epithelia become inflamed and ulcerated, allowing bacteria to enter the bloodstream.[14] One study finds that generalized gingival hemorrhage after tooth brushing carries an almost eightfold risk of developing bacteremia.[13] These results are consistent with another study showing that the incidence and extent of bacteremia after periodontal scaling is significantly higher in periodontitis patients than in gingivitis or healthy patients. The extent of bacteremia correlates with the plaque index and the number of sites with bleeding on probing but not with pocket depth.[15] Periodontitis is a potential risk factor for the translocation of oral bacteria into the bloodstream, which can occur during invasive dental procedures or activities of daily living.[13,15]

Dhotre et al.[16] found that the relationship between periodontitis and bacteremia was significantly higher after extraction in a group of 200 patients than in healthy patients. In another group, they compared blood cultures and subgingival plaque from IE patients with and without periodontitis and found no significant difference in the antibiograms of blood and plaque isolates in periodontitis patients. The viridans streptococci most commonly found in the plaque and blood in periodontitis patients were *Streptococcus mitis*, *Streptococcus oralis*, and *Streptococcus sanguinis*.[16] One finds a strong association of periodontitis to bacteremia and IE risk in the literature. Periodontitis is a preventable and treatable disease; thus, its detection and improvement of patients' oral hygiene plays an important role in the prevention of IE.

The germs encountered in IE can be divided into 4 groups: staphylococci, streptococci, and enterococci, the Gram-negative bacilli (HACEK), facultative and obligate intracellular bacteria.

In addition, there is an infective endocarditis without identifiable germs. Together, the staphylococci, streptococci, and enterococci account for 80-90% of all cases of infective endocarditis.[17]

Antibiotic prophylaxis is the administration of a single dose (single shot) of an antibiotic prior to dental surgery. The 2015 European Association of Cardiology (ESC) guidelines for the management of infective endocarditis[18] placed patients at the highest risk for IE into 3 categories, and recommended prophylaxis only for the following patient groups:

1. Patients with a prosthetic heart valve or with prosthetic material for valve repair. This includes transcatheter implanted prostheses and homografts.
2. Patients with previous IE.
3. Patients with an untreated cyanotic heart defect and patients with postoperative palliative shunts, conduits, and prostheses.

After surgical correction with no remaining defect, the ESC recommends prophylaxis for 6 months until endothelialization of the material.

The American Heart Association (AHA) recommends prophylaxis in the following patients in guidelines published in 2007:

1. Patients with survived IE.
2. Patients with heart valve replacement.
3. Patients with alloprosthetic valve repair (up to 6 months postoperatively).
4. Patients with congenital heart defects (cyanotic heart defects not operated on or operated on palliatively with shunts; with residual defects or conduits; all completely prosthetic heart defects, up to 6 months postoperatively).
5. Patients after heart transplantation with valvulopathy.[4]

Both the ESC and AHA recommend antibiotic prophylaxis for all procedures that require manipulation or perforation of gingiva and the periapical region of teeth.[4,18]

To date, there have been no randomized studies on endocarditis prophylaxis, which means that its efficacy is not proven beyond any doubt[19], thus, the value of prophylaxis remains controversial. This has led to a heated debate among international professional societies resulting in contradictory recommendations.[20] In addition, the implementation of a prospective randomized study would not be possible for ethical, financial, legal, and technical reasons[21], and the question of the correct management of patients at risk remains open.

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AIM

The aim of the present study was to develop a periodontitis-endocarditis model in a rat that can be used to answer the question of how the administration of antibiotic prophylaxis before tooth extraction affects the prevalence of bacteremia and the incidence of endocarditis.

Our hypothesis was as follows: antibiotic prophylaxis decreases bacteremia and subsequently the incidence of IE. To this end, a combined periodontitis-endocarditis model was developed. Two working hypotheses were formulated:

1. Extraction of a periodontally compromised tooth in association with a valvular lesion with foreign body leads to the development of infective endocarditis.

2. Administration of a single dose of antibiotic 30-60 minutes before tooth extraction reduces the risk of developing infective endocarditis.

MATERIALS AND METHODS

Ethical approval

The research was carried out in cooperation with the University of Sofia in the animal laboratory of St Ekaterina University Hospital in Sofia, Bulgaria. The experimental project was officially notified according to the Animal Welfare Act and approved by the local Ethics and Animal Welfare Committee. Animal husbandry and experimentation followed the European Convention for the Protection of Vertebrate Animals used for Experimental and other Scientific Purposes (Council of Europe, Strasbourg 1986), the Guiding Principles of the Society for Laboratory Animal Science (GV-SOLAS).

Experimental design

Thirty-five female Wistar rats were used. We included female animals that weighed 250 g and were at least 8 weeks old. They remained in the vivarium for the entire duration under controlled temperature conditions (23±2°C) and a light cycle of 12 hours light and 12 hours darkness. They were given water with 10% sucrose and commercial rat chow ad libitum.

The sample size was set arbitrarily. No sample size calculation was performed. The group assignment was known to all authors throughout the study.

All thirty-five rats were randomly divided into 3 groups **(Figs 1, 2)**:

- periodontitis group (PG) (n=10): periodontitis was induced by means of ligatures placed bilaterally on the maxillary first molars, the maxillary first molars were extracted after 30 T.
- endocarditis group (EG) (n=13): periodontitis was induced by means of ligatures placed bilaterally on the maxillary first molars, aortic valve injury was achieved by introduction of a catheter, the maxillary molars were extracted after 30 T.

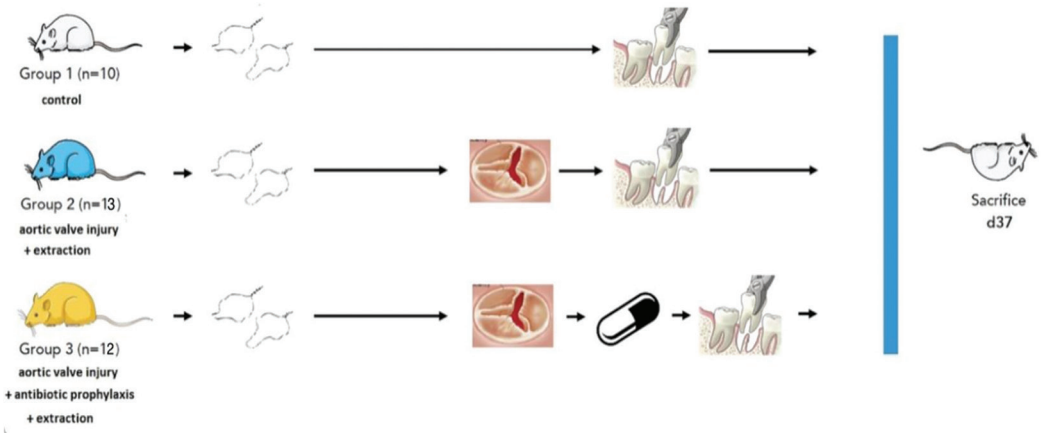

Figure 1. Study design.

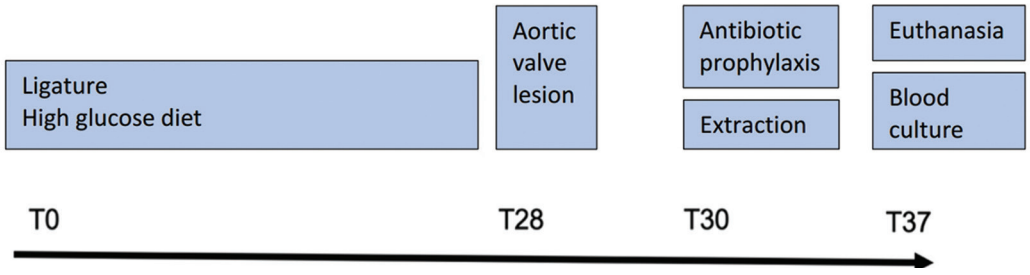

Figure 2. Timeline.

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– antibiotic prophylaxis group (AG) (n=12): periodontitis was induced by means of ligatures placed bilaterally on the maxillary first molars, on day 28, aortic valve injury was achieved by introduction of a catheter, on day 30, 30-60 min before extraction, antibiotic single-shot prophylaxis was performed, followed by extraction.

Euthanasia took place on day 37.

Anesthesia

The rats were anesthetized with ketamine (70 mg/kg) (Ketanest S, Pfizer, Berlin, Germany) and xylazine (8 mg/kg) (Xylapan,Vetoquinol AG, Bern, Switzerland) via intraperitoneal administration.

Periodontitis induction (Fig. 3)

On the first day of the study, all groups (PG, EG, AG) were anesthetized according to protocol.

After successful anesthesia, a 0.25-mm steel wire (Medikor GmbH, Solingen, Germany) was placed orally on the first molar distally through the proximal space (**a**). The ligature was tightened vestibularly and brought mesially. Mesially, both ends of the wire were vestibularly twisted into each other (**b**). The ends were shortened to 1 mm (**d**) and inserted orally into the dental sulcus (**e**, **f**) to avoid self-inflicted trauma to the tongue.

After the procedure, the rats were placed in individual boxes to wake up. During the next 28 days, glucose (10%) was added to the drinking water to promote the development of oral bacteria **(Fig. 3)**.

Aortic valve lesion (Fig. 4)

On day 28, the rats in the EG and AG groups were anesthetized according to the protocol. The procedure was performed using a microscope (3.5×–90× magnification) (Amscope, Irvine, USA). The superficial fascia was longitudinally dissected bluntly to expose the sublingual and submandibular salivary glands. The glands were dissected and moved laterally **(Fig. 4a)**.

The sternocleidomastoid (sternocephalicus) and sternothyroid/sternohyoid muscles were visited under blunt dissection **(Figs 4a, 4b)**. The vagina carotica was then carefully incised. The vagus nerve was separated from the carotid artery using the prong (stump) of Crane-Kaplan forceps **(Figs 4c, 4d)**. The carotid artery was first ligated apically with 4/0 silk ligature (Serag Wiessner, Naila, Germany) **(Fig. 4f)**, and caudally a ligature was placed under it. With gentle traction on the caudal ligature, the blood flow was stopped and with the help of micro scissors a horizontal incision was made **(Figs 4f, 4g)**.

The 0.3-mm polyethylene catheter was inserted to the level of the caudal ligature and the traction on the ligature was broken off **(Fig. 4f)**. Now the catheter could be inserted approximately 2-3 cm to the ascending aorta, through the aortic valve to the digital sensation of elastic resistance, the

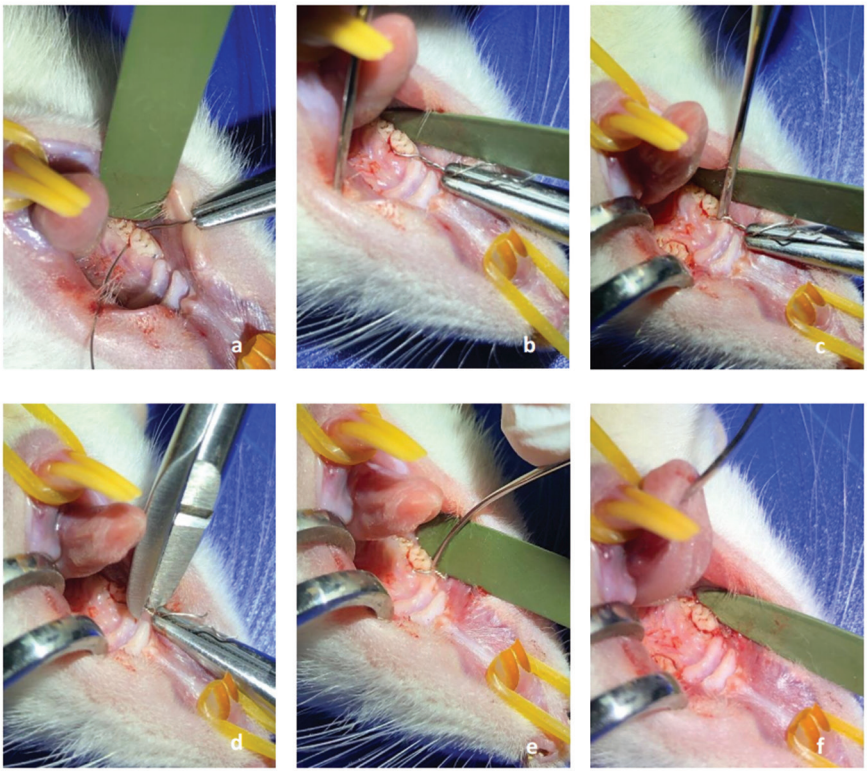

Figure 3. a – f. Placement of wire ligature on the first molar of the maxilla of a Wistar rat.

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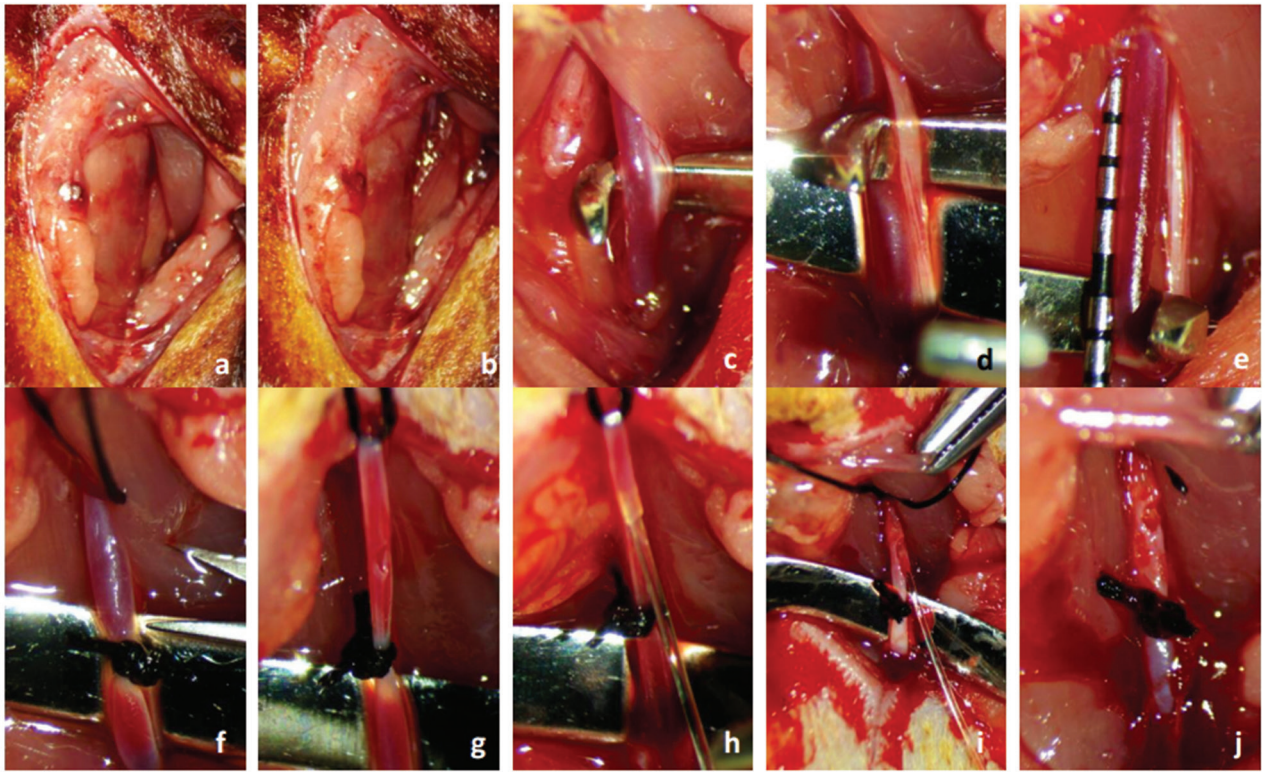

Figure 4. a–j. Catheterization of the right common carotid artery of a Wistar rat.

myocardium at the apex of the left ventricle. The catheter was secured with a double-looped ligature and surgical knots **(Fig. 4i)**. The catheter was then disconnected at the level of the incision **(Fig. 4j)**. The salivary glands were returned to their site of origin, and the wound was irrigated and closed with 4/0 silk ligature. After the procedure, the rats were placed in individual boxes for awakening under observation.

The right carotid artery was exposed through an anterior incision just slightly right of midline above the clavicles. Polyethylene tubing (Intramedic PE 10; Clay Adams, Parsippany, N.J.) was passed through the right carotid artery and into the left ventricle over a 0.008-inch guide wire (American WireCo., Philadelphia, Pa.) until resistance was met. The guide wire was then removed, and the catheter was secured. Cardiac pulsations of the catheter indicated proper placement of the catheter tip at the apex of the heart (Rat Model of Experimental Endocarditis, Santoro, 1978).

Antibiotic prophylaxis

On day 30, the antibiotic group (AG) was given an intragastric administration of amoxicillin (200 mg/kg) and clavulanic acid (50 mg/kg) in the form of suspension (Augmentan forte dry juice, Kohlpharma GmbH, Merzig, Germany). This occurred 60 minutes preoperatively. Application took place by the previously described Gavage procedure.[22] Under manual restraint, a 20 gauge feeding needle (Fischer Scientific, Schwerte, Germany) was inserted into the esophagus and the AB suspension was injected into the stomach.

Tooth extraction (Fig. 5)

On day 30, the rats in the PG, EG, and AG groups were anesthetized according to protocol. First, the approximal plaque index was found according to Lange. Then the ligatures were removed **(Fig. 5b)** to collect periodontal values **(Fig. 5c)** (papilla bleeding index according to Saxer and Mühlemann; pocket depth). The extraction was performed using a root lever inserted distally from oral into the approximal space of the maxillary first molars. The teeth were luxated with a rotating lever movement **(Figs 5d, 5e, 5f)**. After the procedure, the rats were placed in individual boxes for awakening under observation.

Euthanasia, removal of the hearts

On day 37, the hearts were removed for pathohistological evaluation an average of seven days after the extraction and the induced aortic valve lesion. For this purpose, the animals were injected with pentobarbital. The thorax was then exposed and the sternum severed. The heart was lifted with blunt forceps and separated from the vessels and surrounding tissues with surgical scissors. The catheter was palpable when severing the ascending aorta. The heart was placed on a swab and flushed with physiological saline. Hearts were placed in 4% formalin solution or in liquid nitrogen for preservation.

The heart was kept in the formalin vessel for 24 hours. After that, it was placed in physiological saline, numbered, sealed, and stored at 7°C.

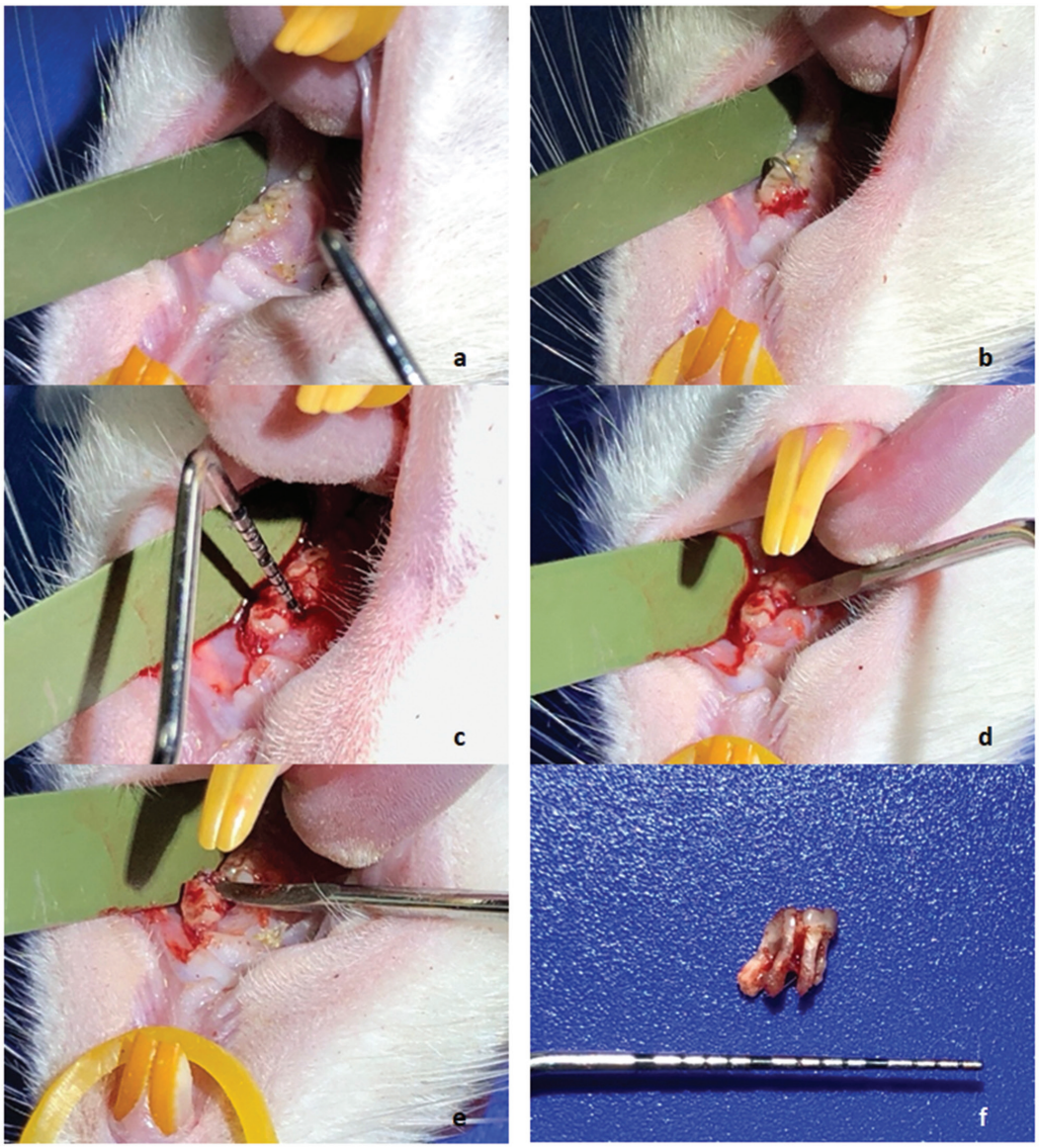

Figure 5. a, b) Removal of the ligature; **c)** Probing of the periodontal pocket; **d, e)** Extraction; **f)** Extracted tooth.

For cryopreservation, the heart was frozen with liquid nitrogen to preserve cell vitality. The samples were numbered and then filled with a glycerin-based embedding medium (Tissue-Tek O.C.T. Compound Sakura, Alpen a/d Rijn, The Netherlands). The heart was applied as bubble-free as possible; the sample was not yet sealed and completely covered with embedding medium. Then the sample was placed in the liquid nitrogen and sealed after a few minutes. The samples were stored permanently at −80°C.

Laboratory procedures

Blood sampling / microbiological examination

Blood cultures were collected from additional experimental animals from groups PG (n=2), EG (n=4), and AG (n=2) on day 37.

From each group (PG, AG, and EG), additional experimental animals were randomly selected for blood collection. Due to the too minimum filling amount of blood culture bottles (10 mL) per blood culture bottle, it was pooled. Blood was collected by sterile transthoracic puncture of the left ventricle with a 21G needle and 5-mL syringe. Blood was introduced into BD Bactec Plus Aerobic/F and BD Bactec Plus Anaerobic/F bottles (BD, Sparks, USA) immediately after collection under sterile conditions and incubated at 36±1°C in a Bactec 9240 blood culture system for up to 30 days.

Positive cultures were removed from the incubator and analyzed. Here, Gram staining of the contained organism in the smear was determined and subculturing was performed on commercial blood, boiled blood, MacConkey or Sabouraud agar. Species determination of Gram-negative germs was performed using standard biochemical methods, and in the case of streptococci and staphylococci, in some cases additionally using agglutination reactions.

Statistical analysis

The histological preparations were examined and the differences of the groups AG, PG, and EG subjected to a significance test ($p<0.05$) by the chi-square test.

RESULTS

Periodontitis

On the day of extraction, 93% of the ligatures were still in situ. Biofilm accumulation was evident on the alloyed teeth as well as a marked tendency of the gingiva to bleed due to manipulation **(Figs 6a, 6b)**. The average approximal plaque index after Lange[23] of maxillary first molars was 92%. The average papilla bleeding index according to Saxer and Mühlemann[24] of the first molar in the first quadrant was grade 3, in the second quadrant – grade 2. The average probing depth of the first molar in the first quadrant was 3 mm, in the second – 2 mm. Bone loss associated with inflammation was visually evident both on radiographs **(Fig. 6c)** and after exposure of the bone **(Fig. 6d)**. These results indicated manifest periodontitis.

Endocarditis

Histopathological examinations revealed the presence of IE in the heart tissue of catheterized rats that survived the procedure of aortic lesion induction and creation of periodontitis **(Fig. 7)**. Endocarditic changes were identified in 20% in the AG group, in 60% in the EG group, and 0% in the PG control group. There was statistical significance ($p<0.05$) in the chi-square test for trend between 'endocarditis' and 'antibiosis' and 'endocarditis' and 'antibiosis'. The aortic valve increased in thickness with marked infiltration of inflammatory cells in the wall of the aorta near the aortic sinus. In comparison to healthy hearts, density of elastic fibers was sparse and bacteria were densely distributed at the outer side of the thrombi and were surrounded by inflammatory cells.

Microbiological examination

The results of the microbiological examination of the blood samples are summarized in **Table 1**. Accessory experimental animals were randomly selected from each group for blood culture testing. In the periodontitis group, the microbiological examination found bacteria of the genus *Bacteroides*, *Staphylococcus aureus* and *Porphyromonas gingi-*

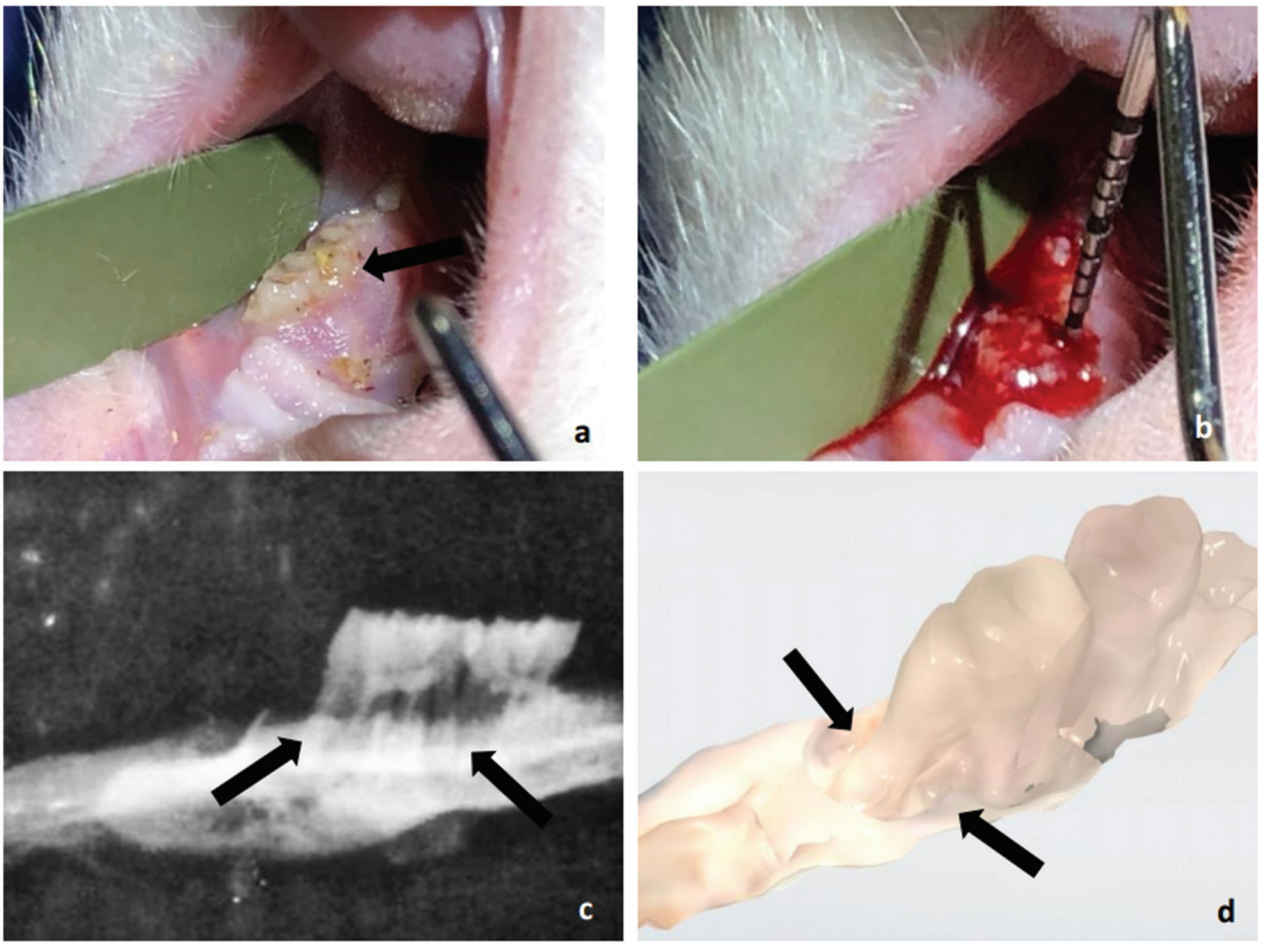

Figure 6. a) Biofilm accumulation on molars (arrow); **b)** Bleeding on probing on the first molar; **c)** X-ray with visible bone loss (arrows); **d)** 3D scan (3Shape, TRIOS 3) of bony relief with visible attachment loss and furcation involvement on first molar (arrows).

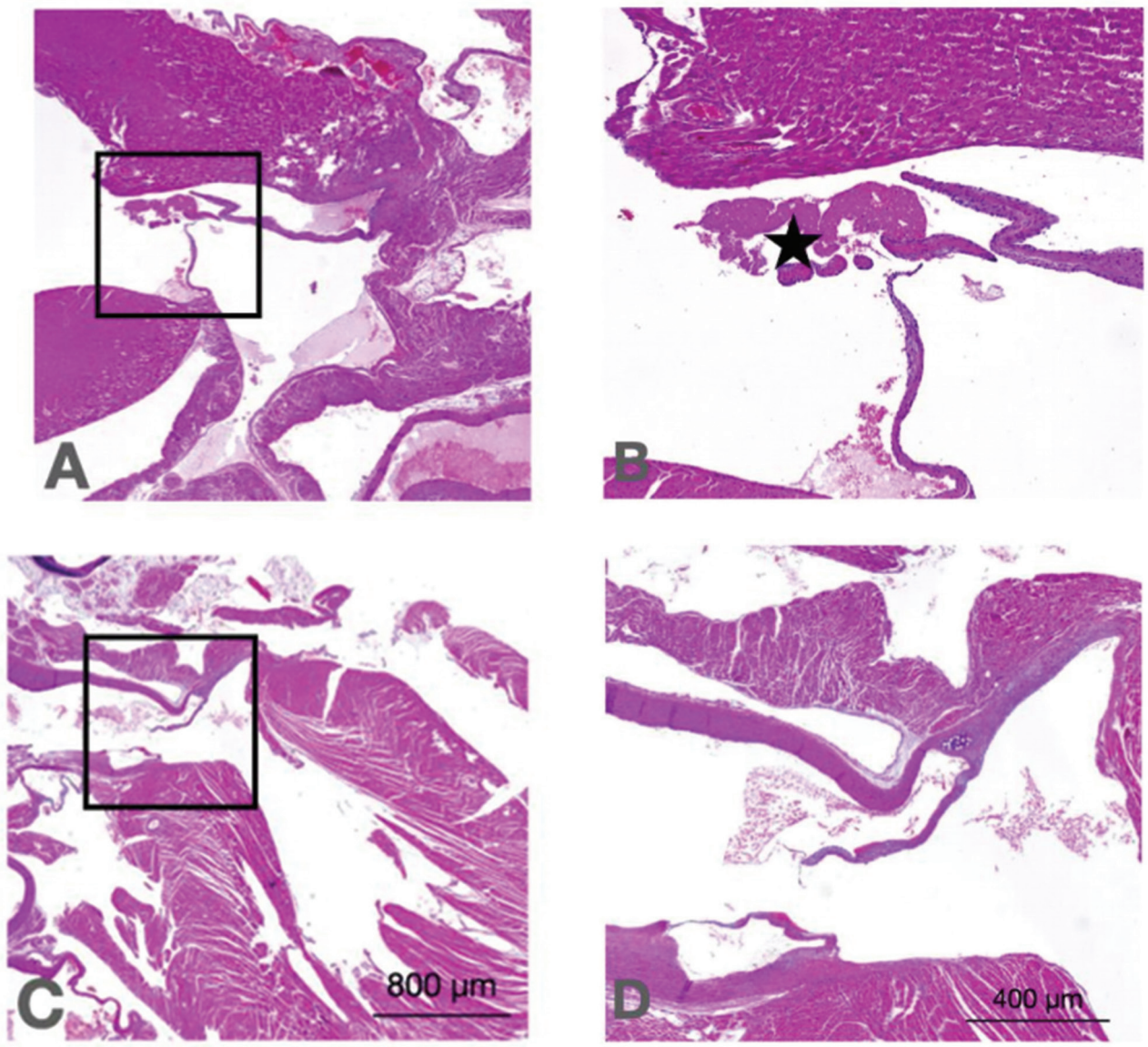

Figure 7. Histological evaluation of rat hearts regarding presence or absence of endocarditic changes of the aortic valve in percent. The endocarditis group (EG, n=13) received dental ligation and catheter-induced injury of the aortic valve, the antibiosis group (AG, n=12) also received dental ligation and catheter-induced injury of the aortic valve with additional single-shot antibiosis, and the control group (PG, n=10) received dental ligation only. ** $p<0.05$ in chi-square test for trend between 'endocarditis' and 'antibiosis' and 'endocarditis' and 'antibiosis'.

Table 1. Results from microbiological blood culture

Groups	#	Aerob	Anaerob
Periodontitis group (PG) (n=2)	1	negative	negative
	2	negative	negative
Endocarditis group (EG) (n=4)	3	negative	*Bacteroides*
	4	*S. aureus*	negative
	5	negative	negative
	6	negative	*Porphyromonas gingivalis*
Antibiotic prophylaxis group (AG) (n=2)	7	negative	negative
	8	*Propionibacteriae*	negative

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valis. In the antibiotic prophylaxis group, *Propionibacteriae* were isolated.

DISCUSSION

In the present study, a combined periodontitis-endocarditis animal model was established. A valvular lesion was created by catheter, acute experimental periodontitis was induced by dental ligations, and bacteremia was induced by extraction of a tooth.

Both working hypotheses could be affirmed: extraction of a periodontally compromised tooth in association with a valvular lesion with foreign body led to the development of infective endocarditis. Histologic examinations revealed cardiac vegetations, allowing a diagnosis of IE according to the modified Duke criteria. A significantly higher incidence ($p<0.05$) of infective endocarditis was found in the EG group than in the AG group. Thus, AB prophylaxis decreased the risk of IE. In this basic rat model study, expertise in dentistry, cardiology, and microbiology were combined to assess the value of antibiotic prophylaxis in dental procedures. This involved using previously described animal experimental models under a new context.

Rats are commonly used in models of experimental periodontitis because the periodontal anatomy in the molar region has some similarities to that of humans. In addition, rats are easy to handle and can be maintained with different genomes and microbial status. In rodent studies, periodontal disease was induced by placing ligatures in the gingival sulcus of molars, resulting in increased biofilm accumulation and disruption of the gingival epithelium, which increased osteoclastogenesis and bone loss.[25] The low rate of loss of dental ligatures in the existing study and the clinical values collected demonstrate this technique as a reliable and feasible method for inducing periodontitis in the rat model.

The rat model of bacterial endocarditis was described as early as 1978 by Santoro and Levinson following the established rabbit model.[26] It has since been used repeatedly and has proved useful in elucidating some of the pathophysiological and therapeutic aspects of the disease. Left-sided endocarditis in rats can be easily and reliably induced. The advantages of the rat model are the parallels of the course of infection and characteristics in humans and the possibility of obtaining statistical endpoints for comparability.

The model of bacteremia of dental origin in rats with an aortic catheter has also been described previously[27], with the animals developing endocarditis in approximately 50% of cases. The four most common bacterial species isolated from blood here 1 minute after tooth extraction were viridans streptococci, gram-negative bacilli (mostly *Morganella morganii*), group G. streptococci, and coagulase-positive staphylococci (*Staphylococcus aureus*).

In our study, the incidence was 60% under similar experimental conditions. The results of blood cultures are consistent with the expected spectrum of germs and confirm post-extraction bacteremia in the studied samples 3, 4, and 6 (in the periodontitis group). Propionibacteriae (sample 8, antibiotic prophylaxis group) are usually considered a contaminant in blood cultures.[28] The isolated organisms have been associated with both oral infections and endocarditis or other infections in the literature.[29-37] Bacteroides are part of the physiological flora of the gastrointestinal tract but are also found in opportunistic infections; namely, intraintestinal sepsis, appendicitis, gynecologic infections, and endocarditis.[29] Some species have been shown to have a regular presence in adult periodontitis and acute necrotizing ulcerative gingivitis[30], a study in the rat model found deep invasion of the gum after association of the test animals with *Bacteroides melaninogenicus* ss. inter-medius a deep invasion of the connective tissue of the gingiva.[31]

Staphylococcus aureus, as described above, is a typical germ for infective endocarditis, often associated with prosthetic material.[32] Studies describe a *S. aureus* presence of 24%-84% in the oral cavity of healthy adults.[33,34] Furthermore, it is associated with several specific oral infections (periodontitis, angular cheilitis, staphylococcal mucositis).[38]

P. gingivalis belongs to the red complex of periodontal pathogens and is thus one of the lead germs of the disease.[35] In a human study, surgically excised cardiac valves and atherosclerotic plaques were examined with their dental plaque and *P. gingivalis* was identified in 10.4% of cardiovascular samples and 50.0% of dental plaque samples.[36]

Propionibacteriae are typically associated with acne (*P. acnes*) and are part of the normal flora of the skin, oral cavity, and GI tract.[37] In human oral flora, it is found in fissure plaque and caries.[35] It is rarely an opportunistic pathogen in relation to postoperative infections of prosthetic material, including infective endocarditis.[37] The development of the presented model could act as a basis for further studies to answer unanswered questions related to oral pathogens and IE.

CONCLUSIONS

The presented model to study the relationship between periodontitis and infective endocarditis is promising due to its practicality and similarity in humans in terms of clinical manifestations, pathology, and ultrastructural changes. The model includes the induction of periodontitis, the generation of a lesion on the aortic valve, and the induction of bacteremia by tooth extraction. The success of each of these is also undermined by intermediate outcomes.

Extraction of a periodontally damaged molar induced bacteremia in Wistar rats. We found a significant reduction in the risk of infective endocarditis by AB prophylaxis in the case of a valvular lesion with simulated prosthetic material in an animal model. The model could act as a basis for further studies on the topic to answer remaining questions related to oral pathogens and IE.

Funding

The materials and instruments were provided by the Danube Private University (Austria).

Informed consent

No personal data was collected. The selection of study participants is limited exclusively to animals.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data availability

All data generated or analyzed during this study are included in this published article.

Author contributions

All authors contributed equally to the preparation of the study.

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Инфекционный эндокардит: стратегия профилактики и факторы риска на модели животных

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Дата получения: 6 января 2023 ♦ **Дата приемки:** 22 февраля 2023 ♦ **Дата публикации:** 31 октября 2023

Образец цитирования: Mitov G, Kilgenstein R, Partenheimer P, Ricart S, Ladage D. Infective endocarditis: prevention strategy and risk factors in an animal model. Folia Med (Plovdiv) 2023;65(5):788-799. doi: 10.3897/folmed.65.e99682.

Резюме

Введение: Инфекционный эндокардит – серьёзное инфекционное заболевание эндокарда, особенно клапанов сердца, связанное с высоким уровнем смертности. Обычно это происходит у пациентов с изменённой и аномальной архитектурой сердца в сочетании с воздействием бактерий в результате травмы и других видов деятельности потенциально высокого риска с транзиторной бактериемией.

Цель: Разработать воспроизводимую модель пародонтита-эндокардита у крыс, которую можно использовать для ответа на вопрос, как назначение антибиотикопрофилактики перед удалением зуба влияет на распространённость бактериемии и частоту эндокардита.

Материалы и методы: Тридцать пять самок крыс линии Wistar были разделены на три группы: группа пародонтита (ГП): лигатуры накладывались билатерально на первые моляры верхней челюсти, моляры верхней челюсти удалялись через 30 Т; группа эндокардита (ГЭ): в дополнение к ГП перед экстракцией выполняли повреждение аортального клапана с использованием имитированного протезного материала; группа антибиотикопрофилактики (ГА): в дополнение к ГЭ проводили однократное введение антибиотика за 30–60 минут до экстракции. Были собраны пародонтальные показатели, проведён микробиологический анализ проб крови. Сердца исследовали гистологически после эвтаназии.

Результаты: В день экстракции 93 % лигатур всё ещё были in situ. Средний аппроксимальный индекс зубного налёта первых моляров верхней челюсти составил 92 %. Средний индекс кровоточивости сосочка по Saxer и Mühlemann первого моляра в первом квадранте составил 3 степени, во втором квадранте – 2 степени. Средняя глубина зондирования первого моляра в первом квадранте составила 3 mm, во втором – 2 mm. Эндокардитические изменения выявлены у 20 % в группе ГА, у 60 % в группе ГЭ и у 0 % в контрольной группе ГП. Была разработана успешная модель достоверно развивающихся эндокардита и пародонтита. Специфические микробы-маркеры пародонтита могут быть обнаружены в культурах крови. Эффективность антибиотикопрофилактики перед удалением зубов в группах риска эндокардита была продемонстрирована на животных моделях.

Заключение: В настоящем экспериментальном исследовании на животных можно разработать воспроизводимую модель путём создания явного поражения пародонта, которое в сочетании с поражением аортального клапана и удалением зуба вызывает бактериемию.

Клиническая значимость

Модель может послужить основой для дальнейших исследований по этой теме, чтобы ответить на оставшиеся вопросы, связанные с оральными патогенами и ИЭ.

Ключевые слова

антибиотикопрофилактика, инфекционный эндокардит, пародонтит, модель крысы