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Original article

Bacterial profile and antibiotic sensitivity in silk sutures following odontectomy

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ABSTRACT

Background: *Impacted teeth, hindered from erupting normally due to space constraints, obstruction by neighboring teeth, or an abnormal eruption pathway, often necessitate surgical intervention known as odontectomy. Silk sutures are commonly used in this procedure, yet they may serve as sites for bacterial colonization, potentially leading to infection. Following odontectomy, antibiotics are typically prescribed.* ***Purpose:*** *This study aims to identify the bacterial profile adhering to silk sutures and analyze antibiotic sensitivity patterns in patients undergoing odontectomy.* ***Methods:*** *A descriptive study employing consecutive sampling of patients after odontectomy was conducted between May and November 2021 at Arifin Achmad General Hospital, Riau Province, Indonesia. Sutures were removed within 14 days of surgery, after which the silk was identified and subjected to antibiotic sensitivity testing using the Kirby–Bauer method.* ***Results:*** *Of the bacteria detected in the silk sutures, 53.7% were Gram positive, including Streptococcus sp. (33.3%) and Staphylococcus aureus (13%), and 46.3% were Gram negative, such as Enterobacter sp. (20.4%) and Klebsiella sp. (16.7%). Among the multi-resistant strains, methicillin-resistant S. aureus (MRSA) accounted for 57.1%. The Gram-positive bacteria exhibited the highest sensitivity to levofloxacin, whereas the Gram-negative bacteria showed sensitivity to ceftazidime, levofloxacin, and meropenem.* ***Conclusion:*** *The most dominant Gram-positive bacteria were Streptococcus sp. and S. aureus, whereas the most dominant Gram-negative bacteria were Enterobacter sp. and Klebsiella sp. Levofloxacin, ceftazidime, and meropenem emerged as the most effective antibiotics following odontectomy. Multidrug-resistant bacteria, exemplified by MRSA, were identified within the oral cavity.*

Keywords: *antibiotics; bacteria; odontectomy; sensitivity; silk*
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INTRODUCTION

Impacted teeth are those that fail to erupt into their normal position. This condition may arise due to a lack of space, obstruction by other teeth, or an abnormal eruption pathway. The prevalence of impacted teeth varies across countries. In Saudi Arabia, the prevalence of impacted teeth is 27.1%.[1] In Yemen, out of 609 examined patients, 236 had impacted teeth.[2] In Iraq, among 500 radiographed patients, 157 (6.28%) had impacted teeth.[3]

Teeth impaction can occur in any tooth, but molars, especially mandibular and maxillary third molars, are most commonly affected. The prevalence of impacted third molars ranges from 16% to 73% in young adults.[4] Impacted mandibular third molars have a prevalence rate of 84.5%.[2] Research by Al-Shamahy[2] reported a prevalence of 38.8% for impacted third molars, with lower third molars less prevalent (15.9%) than upper third molars (22.8%). Other studies have indicated prevalence rates of 60.31% for impacted third molars, 28.73% for canines, 16.82% for second premolars, 2.81% for first premolars, 0.3% for second molars, and 0.1% for incisors.[3]

Treatment for impacted teeth typically involves extraction or odontectomy. Fahira et al.[5] reported treating 102 cases of impacted maxillary third molars, with 12.75% of patients undergoing extraction and 87.25% undergoing

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odontectomy. At the General Hospital of Riau, between May and November 2021, there were 30 cases of odontectomy, primarily in women aged 15 to 55 years.[6]

Odontectomy involves minor surgery that closes the wound with sutures.[7] Sutures are used to bridge or bind disconnected tissue and may serve as sites for bacterial colonization, potentially leading to infection.[8] Sutures used after odontectomy could be continuously contaminated and become a reservoir for bacterial growth.[9]

Different suture materials affect the number of colonizing bacteria. Faris et al.[10] reported a high accumulation of bacteria, including aerobic, anaerobic, and fungi, in silk sutures, increasing the risk of infection, inflammatory reactions, scarring, and prolonged wound healing. This occurs because sutures are made from silk and are usually multifilamentous, providing a good location for bacterial colonization because bacteria can multiply and proliferate, resulting in infection and prolonged wound healing.[11] An article published by Sitorus[12] reported that silk sutures, because of their multifilamentous structure, provide an ideal environment for bacterial colonization, in contrast to catgut, which offers better wound healing but is less biocompatible. Another article, published by de Castro Costa Neto et al.,[13] reported that silk sutures had greater bacterial attachment than nylon, polyglactin 910, and triclosan, with a total of $1.9 \times 10^5 \pm 0.07 \times 10^5$ bacteria identified. Syaflida et al.[14] revealed that the average number of bacteria found on silk sutures was 207.38×10^7 CFU/mL, whereas the average number of bacteria attached to catgut was 115.15×10^7 CFU/mL, which could lead to a higher risk of infection in post-odontectomy wounds sutured by silk.

Postoperative wound infections often result from Gram-positive, Gram-negative, or anaerobic bacteria. Barasa et al.[15] reported that *Staphylococcus aureus* was the most common bacteria implicated in orofacial surgical infections, followed by *Klebsiella* sp., *Pseudomonas* sp., and *Escherichia coli*.

In oral and maxillofacial infections, *Streptococcus* sp., *S. aureus*, and *E. coli* are frequently found.[16] Endriani et al.[6] reported both Gram-positive bacteria (52%), such as alpha-hemolytic streptococci (40.74%), *S. aureus* (22.22%), and coagulase-negative staphylococci (CNS) (37.04%), and Gram-negative bacteria (48%), including *Klebsiella* sp. (56%), *Enterobacter* sp. (32%), *Pseudomonas* sp. (8%), and *E. coli* (4%).

The management of post-odontectomy infection typically involves peroral antibiotics. However, irrational antibiotic use may lead to resistance, including multidrug resistance. Examples of multidrug-resistant bacteria are methicillin-resistant *S. aureus* (MRSA) and extended spectrum β-lactamase (ESBL)-producing Gram-negative bacteria.[17]

The prevalence of MRSA infection in Asian countries is notably high (>50%), particularly in Iran, which has a prevalence of 84.6%.[18,19] In addition, Vellappally et al.[20] reported the prevalence of MRSA as 65.3%. The prevalence of ESBL is also high, with Endriani et al.[17] reporting positive ESBL-producing *E. coli* in 33.33% of cases. Patients with surgical site infections were found to have positive ESBL-producing bacteria, such as *E. coli* (55%), *Klebsiella* sp. (33.1%), and *Proteus* sp./*Pseudomonas* sp. (11.1%).[21]

Silk is a commonly used type of suture among surgeons due to its better tensile strengthand ease of application and knotting. Nevertheless, silk sutures possess a higher risk of bacterial colonization that could lead to an increased risk of infection and the need for antibiotic administration.[14] This study aims to identify bacterial profiles and antibiotic sensitivity patterns in patients undergoing odontectomy with the use of silk sutures.

MATERIALS AND METHODS

This study was conducted at Arifin Achmad Hospital of Riau, Indonesia, and the Microbiology Laboratory, Faculty of Medicine, University of Riau, between May and November 2021. Data collection was performed at the Oral Surgery Clinic, Arifin Achmad Hospital of Riau, utilizing consecutive sampling. Primary data comprised bacterial identification on silk sutures used in post-odontectomy wounds, and secondary data included patient characteristics, such as gender, age, education, and occupation, obtained from medical records. Ethical clearance for this study was granted by the Faculty of Medicine, University of Riau (Decree number: B/058/UN19.5.1.1.8/UEPKK/2021_addendum). The tools and materials used in this study included post-odontectomy silk sutures and standard materials for conventional bacterial culture and identification, such as trypticase soy broth (TSB) medium, blood agar plates (BAP), MacConkey agar plates, and various antibiotic disks.

The study participants were patients who had undergone odontectomy, who were sutured with silk sutures of the same brand, and who attended initial post-procedural controls. The inclusion criteria encompassed patients who had undergone odontectomy and were attending control visits and suture removal within 14 days after odontectomy and who were willing to participate in the research by signing informed consent forms. The exclusion criteria included patients attending control visits with suture removal after 14 days or had removed the sutures themselves. Oral hygiene (OH) index examinations were not conducted in this study.

Silk sutures from patients within 14 days after odontectomy were cut with scissors to approximately 1 cm in length, and one piece of thread was inserted into the TSB medium. The bacteria on the TSB media were then streaked onto BAP and MacConkey agar plates and incubated at 37°C for 18–24 hours. Colonies were identified macroscopically and microscopically using Gram staining. The identification of Gram-positive bacteria involved catalase tests to differentiate staphylococci from

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streptococci, coagulase tests, and novobiocin tests to distinguish *S. aureus* from CNS, the two types of bacteria that are the most commonly identified in infections in the oral cavity. Gram-negative bacteria were identified through biochemical reaction tests, including triple sugar iron agar, hydrogen sulfide, carbon dioxide, indole, citrate, and motility tests. Bacteria were then tested for antibiotic sensitivity using the disc diffusion/Kirby–Bauer method. Clear zones or inhibition zones around the antibiotic discs were measured with calipers in millimeters (mm) and interpreted according to the Clinical and Laboratory Standards Institute criteria according to the type of bacteria and type of antibiotic, with the results classified as sensitive or resistant. The identification of MRSA was performed by testing the sensitivity of *S. aureus* using a 30-μg cefoxitin antibiotic disc (resistant if the diameter is ≤21mm). To identify ESBL strains, this study used presumptive and confirmative tests. The presumptive test used the antibiotic ceftazidime with a clear zone of resistance (clear zone diameter ≤20 mm), and the confirmative test used ceftazidime, cefotaxime, and amoxicillin clavulanate with a clear zone of resistance (clear zone diameter difference ≥5 mm).[22] Data were recorded and presented as percentages in frequency distribution tables.

RESULTS

The present study involved 33 patients undergoing odontectomy using silk sutures. Table 1 summarizes the characteristics of the study participants.

The identification of Gram bacteria was based on culture and Gram-staining results. Gram-positive cocci bacteria yielded positive catalase (staphylococci) and negative catalase (streptococci) test results. Positive coagulase tests indicated *S. aureus*, whereas negative coagulase tests indicated CNS. Furthermore, novobiocin sensitive tests indicated *S. aureus*, and novobiocin resistant tests indicated CNS. The results of the biochemical reaction test for Gram-negative bacilli are summarized in Table 2.

All the collected silk suture samples exhibited bacterial growth (100%) identified as bacterial colonies. A total of 54 types of bacteria were identified from the samples, with some plates showing bacterial growth of more than one type. Based on the identification of the bacterial colonies (Figure 1), the bacterial patterns are listed in Table 3.

Table 1. Characteristics of the study participants

Parameter	N (%)
Gender	
Male	12 (36.4)
Female	21 (63.6)
Age group (years)	
<20 years	9 (27.3)
20–25 years	9 (27.3)
26–30 years	7 (21.2)
>30 years	8 (24.2)
Highest level of education	
Elementary school	0 (0)
Junior high School	3 (9.1)
Senior high School	23 (69.7)
College/University	7 (21.2)
Occupation	
Student	18 (54.5)
Employed/Retired	1 (3)
Private employee/self-employed	10 (30.3)
Farmer/fisher	1 (3)
Homemaker	3 (9.2)

Table 2. Results of the biochemical reaction tests for Gram-negative bacilli

Bacteria	TSIA	H_2S	CO_2	Indole	Citrate	Motility
Escherichia coli	A/A	−	+	−	−	+
Klebsiella sp.	A/A	−	+	−	+	−
Pseudomonas sp.	K/K	+	+	−	+	+
Proteus sp.	K/A	+	−	−		+
Enterobacter sp.	A/A	−	−	−	+	+

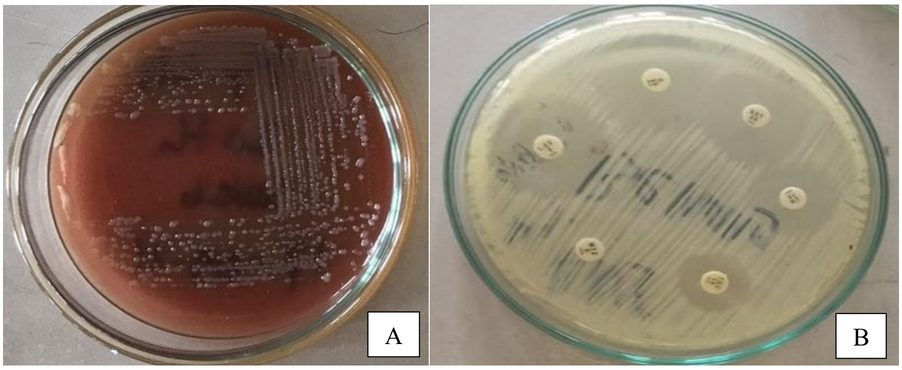

Figure 1. Bacterial colonies (A), and sensitivity test results (B).

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Figure 2 presents the antibiotic sensitivity pattern for all the Gram-positive bacteria (*Streptococcus* sp., *S. aureus*, and CNS*)* isolated from the silk sutures. The Gram-positive bacteria were highly sensitive to levofloxacin (93.1%), gentamicin (86.2%), and meropenem (86.2%). The highest resistance was determined for metronidazole (96.6%), followed by ampicillin (79.3%), ciprofloxacin, and clindamycin (75.9%).

Figure 3 presents the antibiotic sensitivity pattern for all the Gram-negative bacteria (*Enterobacter* sp., *E.coli*, *Proteus* sp., *Klebsiella* sp., and *Pseudomonas* sp.) isolated from the silk sutures. The Gram-negative bacteria were highly sensitive to ceftazidime (92%), levofloxacin (92%), and meropenem (92%), with the highest resistance found for ampicillin (88%). From the seven colonies of *S. aureus* detected, four (57.1%) were identified as MRSA. However, ESBL was not detected after the antibiotic sensitivity test.

Table 3. Bacterial pattern on silk sutures used in odontectomy

Bacteria	N (%)
Streptococcus sp.	18 (33.3)
Coagulase-negative staphylococci	4 (7.4)
Staphylococcus aureus	7 (13)
Total Gram positive	29 (53.7)
Enterobacter sp.	11 (20.4)
Escherichia coli	1 (1.8)
Proteus sp.	1 (1.8)
Klebsiella sp.	9 (16.7)
Pseudomonas sp.	3 (5.6)
Total Gram negative	25 (46.3)

DISCUSSION

In the present study, odontectomy was most prevalent in women (63.6%), aged <20 and 20–25 years (27.3%), with senior high school as the highest education level achieved (69.7%), and who were students (54.5%) (Table 1). Similarly, Rizqiawan et al.[23] reported that out of 916 patients undergoing odontectomy, 59% were women and 41% men. The higher prevalence of women undergoing odontectomy is associated with an earlier halt in physical growth. Jaw growth in women stops after the third molar has erupted, whereas growth continues in men even after the third molar has erupted. This phenomenon results in a smaller jaw size in women.[24] Busra et al.[25] reported that out of 545 patients undergoing odontectomy, 179

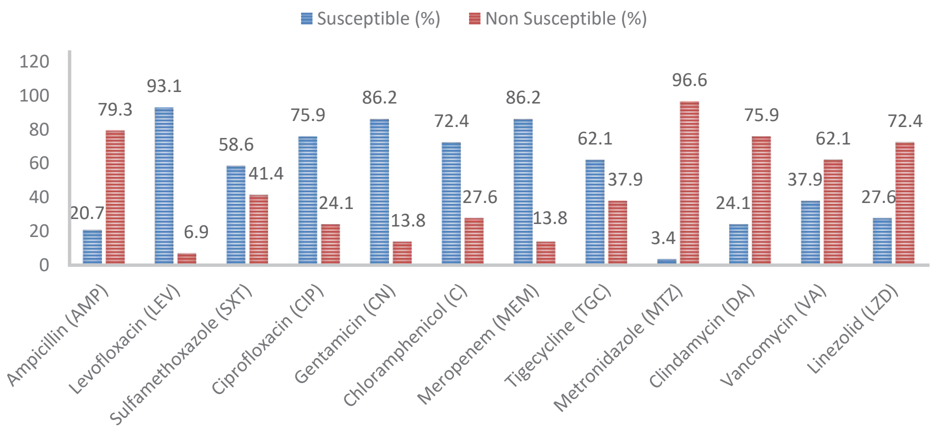

Figure 2. Antibiotic sensitivity pattern for all Gram-positive bacteria (n = 29).

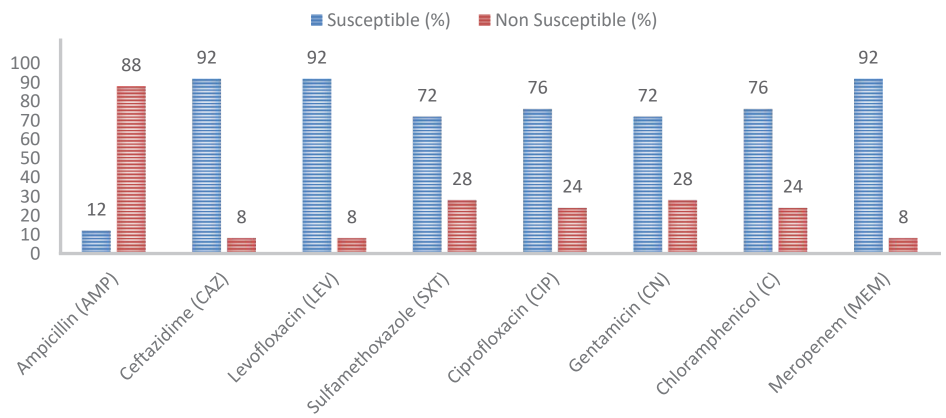

Figure 3. Antibiotic sensitivity pattern for all Gram-negative bacteria (n = 25).

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(32.8%) were aged 20–25 years. This is likely caused by particular eating habits, the intensity of mastication, and genetic factors.[26]

The bacteria present in the silk sutures used in odontectomy are mostly Gram-positive bacteria (Table 3), such as *Streptococcus* sp. and *S. aureus*, whereas the Gram-negative bacteria found include *Enterobacter* sp. and *Klebsiella* sp. Barasa et al.[15] reported that the most common bacteria causing infection in the oral cavity after surgery are *S. aureus* among the Gram-positive bacteria and *Klebsiella* sp., *Pseudomonas* sp., *Proteus mirabilis*, and *E. coli* among the Gram-negative bacteria. Endriani et al.[6] stated that the most common bacteria isolated from odontectomy wounds are Gram-positive and include alpha-hemolytic streptococci, *S. aureus*, and CNS. Moreover, the commonly isolated Gram-negative bacteria are *Klebsiella* sp., *Enterobacter* sp., and *Pseudomonas* sp. Similarly, Nadafpour et al.[27] identified *E. coli, S. aureus,* streptococcus mutants, and *E. faecalis* among the bacteria colonizing silk sutures. The large number of Gram-positive bacteria identified from the oral cavity is because Gram-positive bacteria have adhesins that are associated with cell walls and can bind to collagen and fibronectin proteins. The cell wall of Gram-positive bacteria consists of thick, unchanging peptidoglycans and teichoic acid glycopolymers, which influence the colonization of Gram-positive bacteria to form biofilms that influence antibiotic resistance, whereas Gram-negative bacteria have thin peptidoglycans and lipolysaccharides.[28] The difference in the isolated bacteria is probably caused by an imbalance in the oral cavity ecosystem as a result of medical treatment, biological and pH changes, and poor OH, which could lead to opportunistic infections.[29]

Streptococci can assimilate large amounts of carbohydrates via glycolysis and increase their tolerance to acidic pH. *Streptococcus* sp., as the most dominant bacteria of the oral cavity, possesses several high affinity adhesins that mediate the initial attachment of bacteria to the tooth surface through interactions with salivary substrates, such as albumin, proline, glycoproteins, and mucin. Macromolecules and amylase affect the colonization of streptococcus bacteria in the mouth.[30]

Enterobacter sp. and *Klebsiella* sp., including Enterobacteriaceae, are also commonly found in oral cavity infections. Enterobacteriaceae can spread through saliva, which could worsen a person's health, particularly in patients who are immunocompromised. In these patients, infections can be more severe and develop into systemic infections.[31,32]

This study found that Gram-positive bacteria in silk sutures used following odontectomy exhibit the highest sensitivity to levofloxacin (93.1%), followed by gentamicin (86.2%) and meropenem (86.2%), as shown in Figure 2. The results of this study revealed that *S. aureus* was sensitive to levofloxacin, gentamicin, and meropenem (100%), *Streptococcus* sp. was sensitive to levofloxacin (94.4%), and CNS was sensitive to levofloxacin, ciprofloxacin, gentamicin, chloramphenicol, and meropenem (75%). This study also found that Gram-negative bacteria were most sensitive to levofloxacin, ceftazidime, and meropenem (92%), as shown in Figure 3.

Several other studies similar to ours have also reported that Gram-positive and Gram-negative bacteria generally have high sensitivity to levofloxacin, meropenem, and gentamicin.[6,15,33–38] Endriani et al.[6] and Barasa et al.[15] reported that *S. aureus* was sensitive to cefotaxime, whereas *Klebsiella* sp. showed the highest sensitivity to meropenem, followed by levofloxacin and gentamicin. *Proteus mirabilis* has a high sensitivity to meropenem and levofloxacin. Mwangi[33] reported that aerobic bacteria exhibit sensitivity to levofloxacin, meropenem, and amikacin. Mohseni et al.[34] reported that fluoroquinolone antibiotics, such as levofloxacin and ciprofloxacin, are effective for *Enterobacter* sp. bacteria.

Enitan et al.[35] reported that *Enterobacter* spp. bacteria are most sensitive to levofloxacin. Mustikaningtyas et al.[36] and Rijal and Romdhoni[37] reported the sensitivity of Gram-negative bacteria to meropenem and levofloxacin. Putra et al.[38] reported that both Gram-negative and Gram-positive bacteria are sensitive to meropenem and levofloxacin.

Levofloxacin belongs to the fluoroquinolone group, a bactericidal antibiotic that directly inhibits topoisomerase IV, DNA gyrase, and bacterial DNA synthesis. Levofloxacin promotes DNA strand damage by inhibiting DNA gyrase, an enzyme required for DNA replication, transcription, repair, and recombination in susceptible organisms. This bactericidal antibiotic also demonstrates in vitro activity against a wide range of Gram-positive and Gram-negative microorganisms. In Gram-positive microorganisms, fluoroquinolone works by inhibiting topoisomerase II and IV in bacteria. Topoisomerase II enzymes relax DNA while it is experiencing positive supercooling during DNA replication, whereas topoisomerase IV separates newly formed bacterial DNA.[38] In Gram-negative bacteria, the main target of fluoroquinolone is DNA gyrase. Fluoroquinolone can even bind to secondary targets, which is helpful if the main target has undergone a mutation.[39]

In the present study, MRSA was found in the sample (57.1%). Similar to this finding, Endriani et al.[6] and McCormack et al.[40] reported MRSA being isolated from oral cavity samples (33% and 10%, respectively). Al-Akwa et al.[41] stated that out of 115 isolates of *S. aureus*, 23.5% were MRSA bacteria.

The resistance of MRSA to various antibiotics is divided into β-lactam and non-β-lactam antibiotic resistance. The resistance of β-lactam antibiotics is caused by a mutation that converts penicillin-binding protein (PBP)-2 to PBP2a. The function of PBP2, which is inhibited by β- lactam, is compensated by PBP2a so that transpeptidase activity cannot be inhibited and cell wall synthesis in MRSA bacteria continues to occur. This mutation is caused by the insertion of several nucleotide bases from the substituted β-lactamase operon gene in the PBP2-forming gene called the *mec* gene. The resistance of MRSA that does not occur

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in β-lactam antibiotics is mainly caused by changes in antibiotic receptors that are actively pumped from cells, better known as the efflux mechanism.[42]

In this study, negative results indicated the absence of the ESBL strain in the oral cavity. This result aligns with a study conducted by Søraas et al.[43] on supragingival plaque cultures, which also found no ESBLs.

Patients who are at risk of being infected with ESBL-producing bacteria are often those who are in the intensive care unit and who have a long hospital stay, whereas the participants in this study were patients in outpatient care. Differences in the prevalence of antibiotic-resistant bacteria could be multifactorial, including the irrational use of antibiotics, the severity of the disease, different types of samples, and the methods used, which can produce variations in research results.[17]

Odontectomy, which includes minor surgery, can cause various complications. Ali[44] reported that the most frequently reported complications were pain (40.9%), alveolar osteitis (27.3%), and infection (11.4%). Antibiotics could be given as pharmacological therapy for the infection.[45] Antibiotic administration should always follow the principles and protocols of drug use; thus, they should be appropriate, safe, and rational. The irrational use of antibiotics over a long period increases the resistance of bacteria to antibiotics and even gives rise to multidrug-resistant strains. Clinicians require greater awareness of the increase in antibiotic-resistant and multidrug-resistant bacteria, and research is needed to provide guidelines for antibiotic therapy, especially after odontectomy.[46]

The limitations of this study are not knowing whether the patient was free of antibiotics or prophylactic antibiotics had been administered to the patient before odontectomy, not assessing the patient's OH index and periodontal condition in relation to bacteria prevalence, and the limited number of samples obtained from patients undergoing odontectomy in a limited time; therefore, more samples are needed to be able to describe the actual bacterial pattern and antibacterial sensitivity. It is also necessary to consider administering prophylactic antibiotics to reduce the risk of post-odontectomy infection.

In conclusion, the most dominant bacteria isolated from the silk sutures following odontectomy are *Streptococcus* sp., *S. aureus*, and MRSA for Gram-positive bacteria and *Enterobacter* sp. and *Klebsiella* sp. for Gram-negative bacteria. The most effective antibiotics used after odontectomy are levofloxacin, ceftazidime, and meropenem.

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