

VETERINARY SURGERY



UDC: 619:616.126.4-07:636.7

Bacterial Complication After Surgery Caused by a Multidrug-Resistant Strain of *Staphylococcus pseudointermedius* (MRSP)

Ekaterina A. Lavrova

Veterinary clinic Dr.Pets, St. Petersburg, Russian Federation

Abstract

Introduction. Mast cell tumors (MCTs) are the most common skin tumors in dogs, accounting for 16% to 21% of all skin neoplasms in this species, requiring extensive surgical excision. Despite the routine nature of this surgical procedure, surgical complications are common due to the biological behavior of the tumor, the specific surgical technique, and the possibility of bacterial complications. The purpose of this publication is to describe a clinical case and highlight the increasing prevalence of multidrug-resistant *Staphylococcus pseudointermedius* strains. To the author's knowledge, clinical cases of bacterial skin infection caused by a multidrug-resistant *S. pseudointermedius* strain, which arose as an early postoperative complication following surgical removal of a poorly differentiated mastocytoma, have not previously been described in dogs in the Russian Federation.

Description of a clinical case. The patient, an intact male mixed-breed dog, 8 years old, was admitted with complaints of lethargy, severe pain, swelling, and redness of the skin around the head and left ear. Symptoms developed in the area of the postoperative incision within 72 hours after surgical removal of a low-differentiated mastocytoma during antibiotic therapy with amoxicillin and clavulanic acid. A general examination revealed hyperthermia (39.7 °C), severe swelling, erythema, and exudation around the surgical incision extending to the auricle tissue. Palpation of the affected areas revealed tenderness. The diagnosis was suggested based on the patient's history, clinical presentation, and cytological examination results. After changing the antibiotic and before receiving culture results, significant clinical improvements were noted. The diagnosis was confirmed by culture results.

Discussion. This clinical case confirms the possibility of postoperative bacterial complications associated with multidrug-resistant strains in modern veterinary practice and highlights the need for and feasibility of abandoning the use of protected B-lactam antibiotics as first-line treatments.

Conclusion. The data obtained can be used to initiate further research into the prevalence of resistant bacterial strains in veterinary clinics in our country to further develop infection prevention measures.

Keywords: *Staphylococcus pseudointermedius*, MRSP, bacterial skin infection, bacterial complication, skin mastocytoma, multi-resistant strain, dog

Acknowledgements. The author thanks the staff of the Bacteriology Department of the Veterinary Laboratory “POISK” (Saint Petersburg, Russia), and particularly S.S. Bragina, for providing the microbiological data and for their assistance with the preparation of this clinical case report.

For citation. Lavrova EA. Bacterial Complication After Surgery Caused by a Multidrug-Resistant Strain of *Staphylococcus pseudointermedius* (MRSP). *Veterinary Clinical Cases*. 2026;1(1):7–19.

Бактериальное осложнение после хирургического вмешательства, вызванное мультирезистентным штаммом *Staphylococcus pseudintermedius* (MRSP)

Е.А. Лаврова

Ветеринарная клиника Dr.Pets, г. Санкт-Петербург, Российская Федерация

Аннотация

Введение. Опухоли тучных клеток (ОТК) считаются наиболее распространенными кожными новообразованиями у собак. Они составляют 16–21 % всех дерматологических неоплазий у данного вида, как правило, требуя широкого радикального иссечения. Несмотря на рутинность подобного оперативного вмешательства, постоперационные последствия встречаются часто из-за специфического биологического поведения патологии, особенностей техники проведения процедуры, а также высокой вероятности присоединения вторичной микрофлоры. Цель публикации — подробно описать редкий клинический прецедент, наряду с этим акцентировать внимание практикующих врачей на актуальной проблеме возрастающего распространения мультирезистентных штаммов *Staphylococcus pseudintermedius*. Развитие инфекции кожи как раннего послеоперационного осложнения резекции низкодифференцированной мастоцитомы, вызванной полирезистентным штаммом *S. pseudintermedius* у собак, ранее не описывалось на территории Российской Федерации.

Описание клинического случая. Пациент — собака нестандартной породы (метис), интактный самец в возрасте 8 лет. Животное поступило с жалобами владельцев на вялость, выраженную болезненность, отек и покраснение кожных покровов в области головы и левой ушной раковины. Данные симптомы возникли вокруг послеоперационного шва в течение 72 часов после проведения экстирпации низкодифференцированной мастоцитомы. Патологический процесс стремительно развивался на фоне стандартной антибиотикотерапии препаратом амоксициллина с клавулановой кислотой. При общем объективном осмотре была выявлена гипертермия (температура тела 39,7 °C), значительный отек, эритема, экссудация вокруг хирургической раны с переходом воспаления на мягкие ткани ушной раковины. В ходе пальпации пораженных участков отмечалась сильная болевая реакция. Первоначальный диагноз был установлен на основании собранного анамнеза, манифестации симптомов и результатов предварительного цитологического исследования. После замены антибактериального препарата, еще до получения итоговых данных бактериологического исследования, были зафиксированы выраженные позитивные сдвиги в состоянии пациента. Впоследствии окончательный диагноз полностью подтвердился результатами микробиологического исследования.

Обсуждение. Представленный материал наглядно доказывает возможность развития послеоперационных бактериальных патологий, ассоциированных с мультирезистентной микрофлорой в реалиях современной ветеринарной практики. Данный факт прямо актуализирует вопрос о необходимости и целесообразности отказа от рутинного использования защищенных бета-лактамов антибиотиков в качестве терапевтических средств первого выбора при дерматологических хирургических вмешательствах.

Заключение. Полученные аналитические данные могут быть в дальнейшем успешно использованы для инициации масштабных исследований частоты встречаемости антибиотикорезистентных штаммов бактерий в ветеринарных клиниках нашей страны. Это абсолютно необходимо для последующей разработки эффективных мер строгой профилактики внутрибольничного заражения пациентов.

Ключевые слова: *Staphylococcus pseudintermedius*, MRSP, бактериальная инфекция кожи, бактериальное осложнение, мастоцитома кожи, мультирезистентный штамм, собака

Благодарности. Автор выражает благодарность коллективу бактериологического отдела Ветеринарной лаборатории «ПОИСК» (г. Санкт-Петербург), руководителю бактериологического и молекулярно-генетического отделов ветеринарной лаборатории «ПОИСК», члену Ассоциации Медицинских Микробиологов С.С. Брагиной за предоставленные данные и помощь в описании клинического случая.

Для цитирования. Лаврова Е.А. Клинический случай бактериального осложнения после хирургического вмешательства, вызванный мультирезистентным штаммом *Staphylococcus pseudintermedius* (MRSP). Ветеринарные клинические случаи. 2026;1(1):7–19.

Introduction. Mast cell tumors (MCTs) are the most common skin neoplasms among dogs and account for 16–21% of all dermatological neoplasms of this species [1]. The choice treatment for mastocytomas is extensive surgical excision. A unique feature of normal and tumor mast cells is the presence of granules containing a set of bioactive compounds, including histamine, heparin, proteases, and cytokines [2]. In veterinary medicine, it is widely recognized that the presence of bioactive compounds in mastocytomas contributes to poor wound healing in the postoperative period; however, published studies show contradictory results [2]. In a study by Huttenen et al., it was shown that mast cells and their

mediators (in particular, histamine and heparin) inhibit keratinocyte growth and epidermal regeneration in vitro [3]. Histamine release from mastocytomas can occur spontaneously in physiologically active tumors or be triggered by aggressive manipulation, chemotherapy, or radiation therapy [4]. After the release of these compounds into the local tissue environment, upon physical examination — upon completion of mechanical palpation of the affected area — erythema, edema and papule formation are noted; this phenomenon is known as the Darier's sign [5]. Killick et al tested the hypothesis of unsatisfactory healing of postoperative wounds as part of a retrospective comparison of complications in dogs after complete or incomplete excision with mastocyte and histiocyte, but in the end they were unable to identify differences in outcomes with incomplete and complete excision with mastocyte in the study population [6]. The most frequently described complications after surgical removal of mastocytomas are: suture failure due to large resection margins and high tissue tension, bacterial infections. In one retrospective study, there were no differences in wound healing time or complication rate between dogs undergoing marginal excision of mast cell tumors and dogs undergoing marginal excision of soft tissue sarcomas. The only significant risk factor for complications and delayed wound healing was the use of a skin flap to close an operating wound [7]. Darier's sign in dogs is the rapid appearance of redness, swelling and itching (blister and hyperemia) when touching or manipulating a mast cell tumor, due to the release of histamine (degranulation). It serves as a diagnostic tool for verifying existing neoplasms. It is believed that its appearance after surgical removal potentially indicates the presence of residual, missing, or metastatic tumor cells, but this claim has not been confirmed by research.

Bacterial skin infections are widespread among dogs and in most cases are associated specifically with *S. pseudintermedius*, while for the most part they occur secondarily against the background of itching, allergic reactions or endocrine diseases. *S. pseudintermedius* is a commensal microorganism of the skin microbiome for dogs and can also be found on the skin — mucous borders in the perianal zone, in nose and lip areas. To date, the problem of excessive and irrational use of antibiotics in veterinary medicine persists, which has led to the widespread of resistant strains of microorganisms. The *mecA* gene, which causes the formation of multidrug resistance, encodes penicillin-binding protein (PBP2) on the bacterial cell wall, which ensures its resistance not only to methicillin, but also to all beta-lactam antibiotics, including cephalosporins and carbapenems [8]. Methicillin-resistant *Staphylococcus pseudintermedius* (MRSP) is a serious problem for veterinarians specializing in small animals and for veterinary dermatologists due to the extensive multidrug resistance and characteristics of the nosocomial pathogen. Methicillin-resistant *S. pseudintermedius* was first reported in North America in 1999 [9]. In Europe, the first cases of MRSP-related skin infections were described in 2007, when this pathogen was isolated from 23% of all submitted samples from one reference clinic within a year [10]. In the USA, between 2003 and 2004, MRSP accounted for 17% of all isolated staphylococcal strains [11]. Since then, MRSP has been continuously spreading around the world, and according to numerous studies, infections caused by multidrug-resistant staphylococci are detected almost everywhere [12]. In 2010, a report was published on the prevalence of methicillin-resistant *S. pseudintermedius* in dogs at the veterinary diagnostic laboratory in Italy: among the samples received over a two-month period, the prevalence of MRSP was 21% (0/48) among isolates of the *Staphylococcus intermedius* (SIG) group. All methicillin-resistant strains showed additional resistance to fluoroquinolones, gentamicin, lincosamides, tetracyclines, and potentiated sulfonamides [13]. A Brazilian study published in 2022 reported multidrug resistance (resistance to 3 classes of antimicrobial drugs) observed in 63.2% of *S. pseudintermedius* isolates; 24.5% of them were methicillin-resistant. Half of the MRSP isolates were isolated from infections in the surgical area [14]. The first report on MRSP detected in pyoderma in dogs in China, published in 2012, indicated the detection of this microorganism in 33 of 260 animals (12.7%) [15]. In 2021, the European Food Safety Authority (EFSA) recognized *Staphylococcus pseudintermedius* as one of the three most significant bacteria with antimicrobial resistance in the EU, posing a threat to the health of dogs and cats [16].

Unfortunately, there are currently no large multicenter studies on the prevalence of MRSP in small pets in Russia. According to the bacteriological department of the Veterinary Laboratory “POISK” (St. Petersburg) for the first quarter of 2025, of the 32 samples received by the laboratory labeled “wound discharge”, 40.62% were methicillin-resistant, 59.38% were methicillin-sensitive. A graphical representation of the results is shown in Fig. 1.

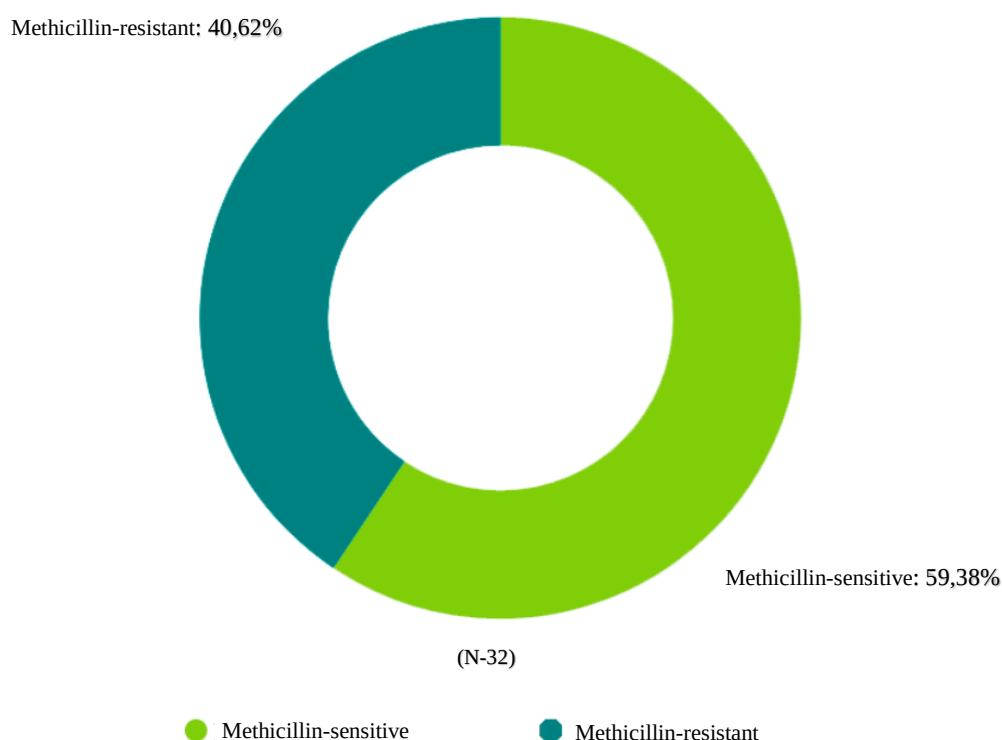


Fig. 1. Frequency of occurrence of methicillin-resistant *Staphylococcus pseudintermedius* isolated from wound skin discharge

As for the MRSP spreading and infection with this pathogen, it is likely that MRSP, like MRSA, is able to colonize clinically healthy animals, while the infectious process develops secondarily as a complication of an underlying disease [17].

Due to the use of modern methods of asepsis and antisepsis, as well as antibiotic therapy after surgery, clinical cases of bacterial complications occurring in the early postoperative period are relatively rare. The uniqueness of the described clinical case lies in the fact that the surgical intervention was performed for a potentially aggressive mast cell neoplasm; before the operation, the patient had never received antibacterial drugs, which potentially reduced the risk of developing MRSP infection. At the same time, the high rate of appearance and progression of clinical signs could lead to an erroneous interpretation of the condition as a complication caused by the biological activity of the neoplasm itself.

Description of the clinical case. The owners of an 8-year-old intact mestizo male turned to a dermatologist for an appointment from a third-party clinic. The main complaints of the owners were: lethargy of the animal, severe soreness, swelling and redness of the skin in the area of the head and left auricle. When collecting the medical history, it was found that the patient had not previously any skin diseases, the dog did not suffer from otitis media and allergic manifestations. Ecto- and endoparasite treatments were carried out regularly; the animal's diet consisted of commercial feed. A few weeks before the treatment, the owners noticed a skin formation that was rapidly increasing in size, and therefore they turned to a surgeon to remove the neoplasm. The surgeon performed an initial diagnosis. The material for cytological examination was obtained from the neoplasm using a fine — needle aspiration biopsy; according to its results, a preliminary diagnosis was established — a low-grade mastocytoma. Before anesthesia, general blood tests were performed — clinical and biochemical, according to the results of which no abnormalities were detected. Three days before going to the dermatologist, the dog underwent surgery to remove a neoplasm in the head area. A few hours after the intervention, the patient was discharged from the hospital for home observation. A protective collar was put on the dog, suture treatments with 0.05% chlorhexidine solution and oral administration of amoxicillin with clavulanic acid at a dose of 18 mg/kg 2 times a day were prescribed. The follow-up examination, suture removal and cancellation of antibiotic therapy were scheduled by the attending physician on the 10th day after the operation. According to the owners, on the 2nd day after the surgery, despite following all the recommendations, redness around the stitches was noted; the dog began to show concern. During the day, erythema spread to the auricle area, the animal stopped allowing it to touch the ear, and crusts also began to appear. The attending physician recommended that you make an appointment with a dermatologist.

On general examination, the only pronounced abnormalities were hyperthermia (39.7°C) and soreness in the affected area. Dermatological examination revealed: edema, erythema and exudation in the area of the left side of the muzzle and the left auricle, spreading to the eyelid area and the ipsilateral surface of the neck (Fig. 2). There were also areas of erosion along the edge and on the inner surface of the auricle, small crusts. Small papules were visualized along the periphery of the erythema zone. The entrance to the auditory canal was stenosed due to edema.

The following diagnostic tests were performed: a general clinical blood test, which revealed leukocytosis with a shift of the leukocyte formula to the left; cytological examination of prints from the skin surface and from under the crusts, as well as fine needle aspiration biopsy of the skin with the collection of material for cytological examination and bacteriological culture.

Cytological examination of the obtained samples was performed immediately after taking the material. The material was stained according to Romanovsky. Microscopic examination was performed using a Micmed-6 microscope (LOMO, the Russian Federation). In the material obtained from the surface and from the thickness of the skin, multiple degenerative neutrophils and numerous free-lying coccoid microorganisms were found (Fig. 3, 4); in separate fields of vision, the coccoid microflora was located in large groups (Fig. 5), phagocytosis of coccoid bacteria was also noted. No eosinophils or mast cells were detected in the presented samples; free-lying granules of these cells were also not detected. The cytological picture corresponded to neutrophilic inflammation. The material for bacteriological examination was sent to the laboratory.



Fig. 2. The clinical picture of the lesions at the initial examination on the day of treatment. Edema, erythema of the skin, exudation in the area of the left side of the muzzle, the left auricle, spreading to the eyelid area and the ipsilateral surface of the neck

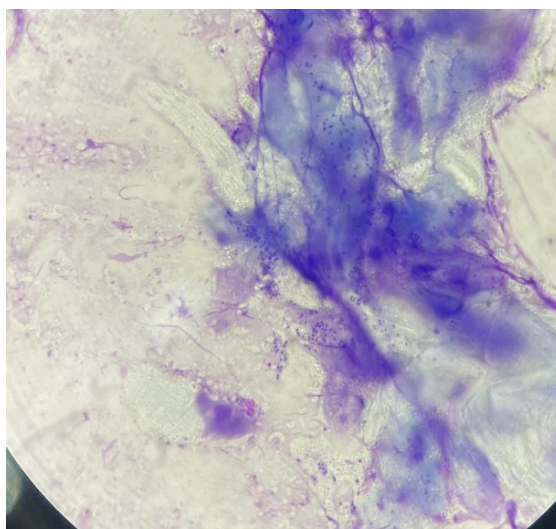


Fig. 3. The colored preparation. A smear is an imprint from the surface of the skin. Immersion magnification

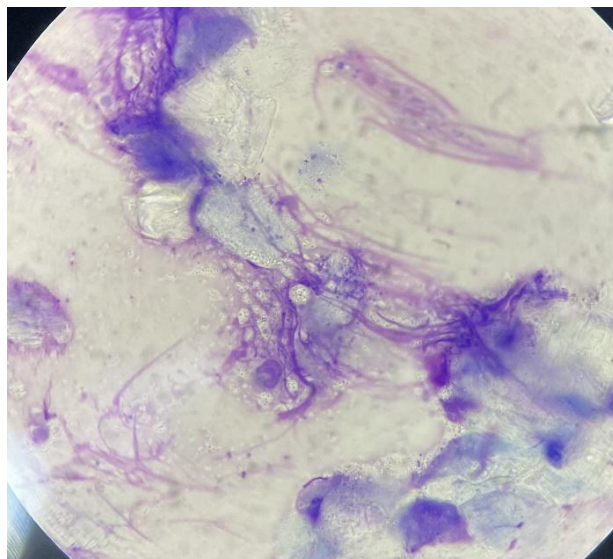


Fig. 4. The colored preparation. The material was obtained by fine needle biopsy from the skin. Immersion magnification

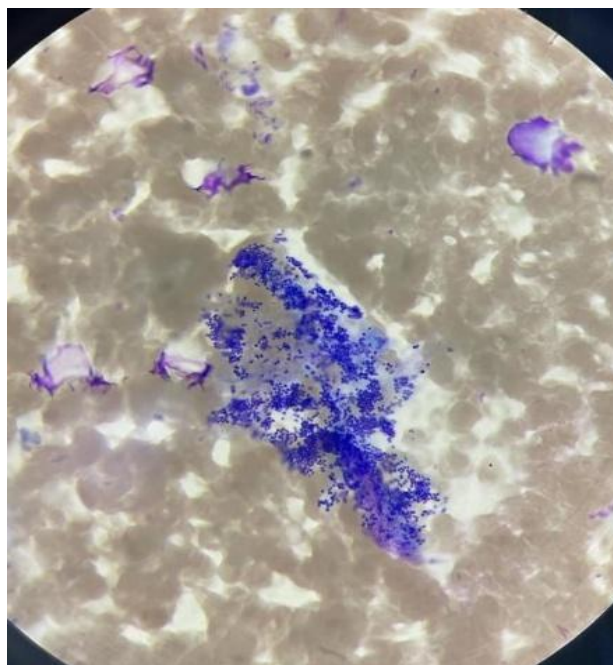


Fig. 5. A large accumulation of coccoid microorganisms in one of the visual fields. The material obtained by fine needle biopsy from the skin thickness. Immersion magnification

Regarding the ways of transmission and infection of MRSP, it should be noted that this microorganism, most likely, colonizes healthy animals in a similar way to MRSA, whereas the infectious process develops secondarily in the form of complications of the underlying disease [17]. Due to the use of modern methods of asepsis and antisepsis, as well as the implementation of antibiotic prophylaxis protocols after surgery, cases of bacterial complications in the early postoperative period are rarely reported. The scientific significance of the described clinical case is due to the fact that surgical intervention was performed for a potentially aggressive mast cell neoplasm, while the patient had not previously received antibiotic therapy, which minimized the risk of MRSP carriage. The high rate of progression of symptoms could lead to erroneous conclusions about complications determined by the biological activity of the tumor itself.

The list of differential diagnoses included: deep pyoderma, auricular chondritis associated with deep pyoderma, incisional complications due to possible incomplete resection of the mastocytoma, as well as dissemination of the process. Based on cytological examination data, bacterial skin infection was considered the most likely diagnosis. It is not possible to completely exclude incisional complications based on cytology alone, however, the absence of mast cells in the obtained material significantly reduced the likelihood of this diagnosis. Due to the rapid manifestation and aggressive nature of the infection, it was suggested that its etiology was caused by a bacterial strain resistant to previously prescribed therapy (amoxicillin with clavulanic acid). As a result, it was decided to replace the drug with a representative of the lincosamide group.

The patient was prescribed clindamycin orally at a dose of 11 mg / kg with an interval of 12 hours until the results of a bacteriological examination were obtained, as well as antiseptic treatment of the affected areas with 0.5% chlorhexidine solution. The owners were informed of the need to notify the doctor urgently if their condition worsened or there was no clinical response within 72 hours. Despite the presence of severe pain, anti-inflammatory drugs were not included in the therapeutic plan. Nonsteroidal anti-inflammatory drugs were not used due to the possible need to switch to glucocorticosteroids. The use of steroids, in turn, was postponed until the seeding data was received due to the likelihood of a repeat biopsy or a repeat surgical stage.

Upon repeated examination on the 5th day of treatment, a positive trend was recorded. Erythema and edema significantly regressed, algesia decreased, and exudation stopped. Residual effects in the form of peeling and small crusts were observed. An ulcer with exudative processes, perifocal cortical formation and exposure of auricular cartilage was detected in the area of the rostral margin of the auricle (Fig. 6–8).



Fig. 6. Appearance of lesions on the 5th day of therapy



Fig. 7. Appearance of lesions on the 5th day of therapy



Fig. 8. The appearance of lesions on the 5th day of therapy

By the time of the second examination, the result of the bacteriological examination was ready (Table 1).

Table 1

The result of a bacteriological examination with determination of sensitivity to antibiotics

Seeding for flora and AC <i>Staphylococcus pseudointermedius</i> 10 ⁷ CFU/tamp	
Sensitivity to drugs	
Oxacilline	R
Ampicillin	R
Amoxicillin	R
Lincomycine	S
Clindamycin	S
Amoxicillin clavulanat	R
Co-trimoxasol	S
Chloramphenicol	S
Cefixime	R
Cefalexin	R
Cefotaxime	R
Ceftriaxon	R
Gentamicin	R
Ciprofloxacin	R
Erythromycin	S
Azithromycin	S
Tetracycline	R
Doxycycline	S
Enrofloxacin	R
Comment: S —sensitive, R — resistant, I — moderately resistant. Localization is a wound discharge from the skin.	

Based on the results of the bacteriological examination, it was recommended to continue the prescribed antibiotic therapy until the next follow-up examination with the attending surgeon, scheduled in 2 weeks. Additionally, the ulceration area was treated with a cream with 1% silver sulfadiazine 2 times a day.

Subsequent follow-up examinations were performed by the attending surgeon. On the 14th day after the surgery, the patient's stitches were removed.

At a follow-up examination after 3 weeks, a skin defect in the form of an ulcer remained in the area of the auricle edge. The central part of the ulcer became deeper, while its edges began to epithelize along the periphery. Otherwise, the skin in the surgical area and on the inner surface of the auricle showed no signs of inflammation, edema and exudation were absent (Fig. 9).



Fig. 9. Appearance of the skin lesion in the 3rd week of follow-up

Clindamycin antibiotic therapy in this patient lasted a total of 6 weeks. Then, only external treatments with 0.05% chlorhexidine solution and 1% silver sulfadiazine cream were used until the ulcer completely healed, which took about 10 weeks. According to the results of the histological examination, a surgically clean edge was confirmed. 8 weeks after the initial appointment with a dermatologist, an ulcer persisted in the area of the auricle margin, while the surrounding tissues showed no signs of inflammation (Fig. 10).



Fig. 10. The appearance of the lesion after 8 weeks

Discussion. Based on the research results obtained and the good response to antibiotic therapy, it can be argued that in this case there was a bacterial complication caused by the multidrug-resistant strain of *St. pseudointermedius*. The decision to replace the antibiotic with a drug from the lincosamide group, clindamycin, which, like amoxicillin with clavulanic acid, belongs to the first line of antibiotic therapy in dermatology, which is reflected in modern recommendations for the use of antimicrobials in pyoderma in dogs [18], proved to be justified. It is reported that up to 97.8% of isolates of methicillin-resistant *S. pseudointermedius* (MRSP) demonstrate multidrug resistance to three or more antibiotics commonly used in veterinary medicine [19]. The choice of an antibacterial drug of another group, for example, fluoroquinolones, could be associated with the further development of antibiotic resistance, which is especially dangerous in an oncological patient due to the potential need for repeated surgery or chemotherapy.

Methicillin-resistant *S. pseudointermedius* is rapidly becoming one of the leading causes of various opportunistic infections, including pyoderma and surgical infections. Literature data on the prevalence of MRSP-related bacterial infections as complications after surgery are limited. In a retrospective analysis of antimicrobial-resistant isolates from surgical wounds and bite wounds in dogs and cats conducted in Italy, it was reported that methicillin resistance was detected in most isolates of *Staphylococcus aureus* and several isolates of *S. pseudointermedius* [20]. Surgical infection was reported in 71 out of 659 (11%) patients after osteotomy of the tibial plateau in dogs, while methicillin-resistant *Staphylococcus pseudointermedius* caused 20 out of 71 (28%) cases of infection [21]. As far as the author is aware, this clinical case is the first in Russia to describe an infection caused by the multidrug-resistant *Staphylococcus pseudointermedius* that occurred after surgical removal of a low-grade mastocytoma in a dog. The risk factors for MRSP infection have not been fully studied and require further research, however, staying in a hospital in a clinic where antibiotics are actively used and resistant strains can circulate is probably a predisposing factor. Further research is also needed on the frequency of occurrence of resistant nosocomial strains common in veterinary clinics in our country in order to develop measures to prevent infection with such strains and effective disinfection methods.

Under the current conditions, the absence of a history of antibiotic use does not exclude the possibility of MRSP strains in patients. In one study, MRSP isolates were obtained from healthy dogs in 2000–2002 and 2009; their proportion among all *S. pseudointermedius* isolates was 34.8% (24 out of 69) and 69.6% (32 out of 46), respectively [22]. In another study, the long-term colonization of dogs with MRSP bacteria was evaluated, and ways of transmitting infection to humans, contact animals, and environmental objects were studied. Contact animals positive for MRSP were found in 6 of these 7 households. As a rule, contact animals positive for MRSP were detected only in the presence of index dogs also positive for MRSP. However, in one household, the index dog became negative for MRSP, while the contact animal was repeatedly positive for MRSP. At the first sampling, 3 out of 25 (12.0%) people from three different households tested positive for MRSP. During the next four sampling sessions, none of the human nasal cavity samples tested positive for MRSP. At the last sampling, 2 out of 22 (10.0%) people from the same household tested positive for MRSP [23]. This is due to MRSP transmission routes, including domestic ones.

There is evidence of transmission of MRSP strains from infected dogs to the environment and owners [24]. Another study reports widespread household MRSP infection: positive samples were found in 70% of households, and 44% of all environmental samples tested positive for MRSP. In all but one of these households, when the index case was positive for MRSP, the animal remained positive for MRSP [25]. Among the staff of veterinary clinics, 4 out of 141 (3%) were positive for MRSP. MRSP was isolated from 31 out of 200 environmental samples in 7 out of 13 clinics during the first sampling, and in 3 out of 6 clinics, the environment remained positive for MRSP after cleaning and disinfection, indicating the insufficient effectiveness of existing sanitation procedures to eliminate MRSP [25]. In veterinary training clinics, mobile phones can be contaminated with MRSP and MRSA, two opportunistic pathogens that pose a serious danger [26]. During the examination of veterinarians and staff of veterinary clinics, MRSP was detected in 3-5.3% of nasal mucosa flushes [27]. Hospitalization and visits to the veterinary clinic are risk factors for MRSP infection; this pathogen should be considered as a hospital infection. An analogy can be drawn between hospital infections in veterinary medicine and human medicine, in particular with the epidemiology of multidrug-resistant staphylococcus aureus (MRSA). Methicillin-resistant *Staphylococcus pseudintermedius* (MRSP) is one of the main causes of bacterial infections in dogs worldwide [28].

In the case of this patient, despite the high-quality surgical training, there is a reason to believe that the multidrug-resistant bacterial strain was acquired during surgery. Preoperative skin asepsis is one of the preventive measures used to reduce the incidence of infectious complications, as well as to limit the spread of antibiotic resistance. One study evaluated the effectiveness of two protocols of preoperative skin asepsis in dogs using an aqueous solution of 7.5% povidone iodine or an alcoholic solution of 2% chlorhexidine. Both protocols were found to be effective: bacterial growth was absent in both animals treated with povidone-iodine (74%) and animals treated with chlorhexidine (70%). At the same time, bacterial growth persisted after treatment with povidone-iodine in 26% of cases and chlorhexidine in 30% of cases [29].

To prevent complications in all patients, strict adherence to the rules of asepsis, antisepsis and hygiene in the clinic is necessary, as well as the introduction of comprehensive training for staff and animal owners. Most infections in the surgical area are caused by commensal and pathogenic agents of the patient's microbiota, which may include antibiotic-resistant strains. Preoperative skin asepsis is one of the preventive measures aimed at reducing the incidence of infectious complications and limiting the spread of antibiotic resistance. Based on the above, it is necessary to develop new measures to prevent infection of patients with strains of multidrug-resistant microorganisms, improve hygiene approaches in veterinary clinics and establish careful monitoring of their implementation. Based on the new recommendations for the treatment of bacterial skin infections in dogs, it can be concluded that the choice of a first-line antibacterial drug should be based not only on international recommendations, but also on statistics on the spread of MRSP in a particular region, which requires large-scale studies of the prevalence of MRSP strains in Russia. The continued widespread use of protected beta-lactam antibiotics, in particular amoxicillin with clavulanic acid, as first—line therapy in all areas of veterinary medicine — neonatology, surgery, dermatology, gastroenterology, emergency medicine, reproductive medicine, and others - may soon lead to a 100% prevalence of MRSP. According to various national and clinical studies, beta-lactams account for approximately 70% of antimicrobial drug consumption in the veterinary sector in Australia [30], Italy [31] and Denmark [32]. As far as the author, he is aware that there are no such studies conducted in Russia, however, the situation is probably similar. There is already an urgent need not only to limit the use of antibiotics, but also for a rational approach, which should consist in avoiding the use of protected beta-lactams as first-choice drugs and replacing them with drugs with a narrower spectrum of action. In large cities, the number of patients with atopic dermatitis, who often suffer from superficial bacterial skin infections, including MRSP carriers, has increased significantly over the past decades. In addition to observation by a dermatologist, such patients often undergo surgical interventions — removal of neoplasms, surgical treatment of a ruptured anterior cruciate ligament, and other operations. After such interventions, the surgeon often prescribes short courses of first-choice antibiotics, lasting up to 10 days, without clarifying the medical history and coordinating tactics with the treating dermatologist, which can also contribute to the spread of highly resistant MRSP strains.

Conclusion. This clinical case confirms the importance of timely feedback between the pet owner and the attending physician, especially in the early postoperative period. In this patient, good compliance with the owners made it possible to identify the complication in time and start therapy. Despite a fairly long recovery period, more serious consequences were avoided.

Dogs that have not previously received antibiotic therapy may be potential carriers of MRSP strains. Further studies of the frequency of occurrence of resistant nosocomial strains common in veterinary clinics in our country are required in order to develop measures to prevent infection with such strains and effective disinfection methods.

Good compliance with owners and colleagues helps to identify postoperative complications in a timely manner and effectively treat them. There is already an urgent need not only to limit the use of antibiotics, but also for a rational approach, which should consist in avoiding the use of protected beta-lactams as first-choice drugs and replacing them with drugs with a narrower spectrum of action.

References

1. Ribeiro PR, Bianchi MV, Bandinelli MB et al. Pathological aspects of cutaneous mast cell tumors with metastases in 49 dogs. *Veterinary Pathology*. 2022;59(6):922–930. <https://doi.org/10.1177/03009858221114468>
2. Iodence AE, Wallace ML, Grimes JA. Dogs undergoing surgical excision of mast cell tumors are not at increased risk of incisional complications. *Journal of the American Veterinary Medical Association*. 2021;260(S1):S88–S95. <https://doi.org/10.2460/javma.20.09.0488>
3. Huttunen M, Nilsson G, Butterfield JH, Horsmanheimo M, Harvima IT. Inhibition of keratinocyte growth in cell culture and whole skin culture by mast cell mediators. *Exp Dermatol. Experimental dermatology*. 2001;10(3):184–192. <https://doi.org/10.1034/j.1600-0625.2001.010003184.x>
4. Ishiguro T, Kadosawa T, Takagi S, et al. Relationship of disease progression and plasma histamine concentrations in 11 dogs with mast cell tumors. *Journal of Veterinary Internal Medicine*. 2003;17(2):194–198. <https://doi.org/10.1111/j.1939-1676.2003.tb02433.x>
5. de Nardi AB, dos Santos Horta R, Fonseca-Alves CE, de Paiva FN, Linhares LCM, Firmo BF, Ruiz Sueiro FA. et al. Diagnosis, Prognosis and Treatment of Canine Cutaneous and Subcutaneous Mast Cell Tumors. *Cells*. 2022;11(4):618. <https://doi.org/10.3390/cells11040618>
6. Killick DR, Rowlands AM, Burrow RD, Cripps P, Miller J, Graham P, Blackwood L. Mast cell tumour and cutaneous histiocytoma excision wound healing in general practice. *Journal Small Anim Practice*. 2011;52(9):469–475. <https://doi.org/10.1111/j.1748-5827.2011.01093.x>
7. Cockburn E, Janovec J, Miguel A, L'Eplattenier H. Marginal excision of cutaneous mast cell tumors in dogs was not associated with a higher rate of complications or prolonged wound healing than marginal excision of soft tissue sarcomas. *Journal of the American Veterinary Medical Association*. 2022;260(7):741–746. <https://doi.org/10.2460/javma.21.05.0235>
8. van Duijkeren E, Catry B, Greko C, Moreno MA, Pomba MC, Pyörälä S. et al. Review on methicillin-resistant *Staphylococcus pseudintermedius*. *The Journal Antimicrobial Chemotherapy*. 2011;66(12):2705–2714. <https://doi.org/10.1093/jac/dkr367>
9. Frank LA, Loeffler A. Methicillin-resistant *Staphylococcus pseudintermedius*: clinical challenge and treatment options. *Veterinary Dermatology*. 2012;23(4):283–292. <https://doi.org/10.1111/j.1365-3164.2012.01047.x>
10. Loeffler A, Linek M, Moodley A, Guardabassi L, Sung JML, Winkler M. et al. First report of multiresistant, mecA-positive *Staphylococcus intermedius* in Europe: 12 cases from a veterinary dermatology referral clinic in Germany. *Veterinary Dermatology*. 2007;18(6):412–421. <https://doi.org/10.1111/j.1365-3164.2007.00635.x>
11. Morris DO, Rook KA, Shofer FS, Rankin SC. Screening of *Staphylococcus aureus*, *Staphylococcus intermedius*, and *Staphylococcus schleiferi* isolates obtained from small companion animals for antimicrobial resistance: a retrospective review of 749 isolates (2003–04). *Veterinary Dermatology*. 2006;17(5):332–337. <https://doi.org/10.1111/j.1365-3164.2006.00536.x>
12. Nocera F.P., De Martino L. Methicillin-resistant *Staphylococcus pseudintermedius*: epidemiological changes, antibiotic resistance, and alternative therapeutic strategies. *Veterinary Research Communications*. 2024;48(6):3505–3515. <https://doi.org/10.1007/s11259-024-10508-8>
13. De Lucia M, Moodley A, Latronico F, Giordano A, Caldin M, Fondati A. et al. Prevalence of canine methicillin resistant *Staphylococcus pseudintermedius* in a veterinary diagnostic laboratory in Italy. *Research in Veterinary Science*. 2011;91(3):346–348. <https://doi.org/10.1016/j.rvsc.2010.09.014>
14. Viegas FM, Santana JA, Silva BA, Xavier RGC, Bonisson CT, Câmara JLS. et al. Occurrence and characterization of methicillin-resistant *Staphylococcus spp.* in diseased dogs in Brazil. *PLoS One*. 2022;17(6). <https://doi.org/10.1371/journal.pone.0269422>
15. Wang Y, Yang J, Logue CM, Liu K, Cao X, Zhang W. et al. Methicillin-resistant *Staphylococcus pseudintermedius* isolated from canine pyoderma in North China. *Journal of Applied Microbiology*. 2012;112(4):623–630. <https://doi.org/10.1111/j.1365-2672.2012.05233.x>
16. Nielsen SS, Alvarez J, Calistri P, Canali E, Drewe JA, Garin-Bastuji B. et al. Guidance on good practice in conducting scientific assessments in animal health using modelling. *EFSA Journal*. 2022;20(5):1–34. <https://doi.org/10.2903/j.efsa.2022.7346>
17. Bryan J, Frank LA, Rohrbach BW, Burgette LJ, Cain CL, Bemis DA. Treatment outcome of dogs with methicillin-resistant and methicillin-susceptible *Staphylococcus pseudintermedius* pyoderma. *Veterinary Dermatology*. 2012;23(4):361–e65. <https://doi.org/10.1111/j.1365-3164.2012.01034.x>
18. Loeffler A, Cain CL, Ferrer L, Nishifuji K, Varjonen K, Papich MG. et al. Antimicrobial use guidelines for canine pyoderma by the International Society for Companion Animal Infectious Diseases (ISCAID). *Veterinary Dermatology*. 2025;36:234–282. <https://doi.org/10.1111/vde.13342>

19. Lynch SA, Helbig KJ. The Complex Diseases of *Staphylococcus pseudintermedius* in Canines: Where to Next? *Veterinary Sciences*. 2021;8. <https://doi.org/10.3390/vetsci8010011>
20. Danieli D, Amadori M, Crimi S, Pregnotato F, Caruso C. et. al. Antimicrobial Resistant Isolates in Surgical and Bite Wounds in Dogs and Cats: A 12-Year Retrospective Analysis. *Animals*. 2026;16(3):501–521. <https://doi.org/10.3390/ani16030501>
21. Hagen CRM, Singh A, Weese JS, Marshall Q, Linden Az, Gibson TWG. Contributing factors to surgical site infection after tibial plateau leveling osteotomy: A follow-up retrospective study. *Veterinary Surgery*. 2020;49(5):930–939. <https://doi.org/10.1111/vsu.13436>
22. Onuma K, Tanabe T, Sato H. Antimicrobial resistance of *Staphylococcus pseudintermedius* isolates from healthy dogs and dogs affected with pyoderma in Japan. *Veterinary Dermatology*. 2012;23(1):17–e5. <https://doi.org/10.1111/j.1365-3164.2011.00995.x>
23. Laarhoven LM, de Heus P, van Luijn J, Duim B, Wagenaar JA, van Duijkeren E. Longitudinal study on methicillin-resistant *Staphylococcus pseudintermedius* in households. *PLoS ONE*. 2011;6(11). <https://doi.org/10.1371/journal.pone.0027788>
24. Roken M, Iakhno S, Haaland AH, Wasteson Y, Bjelland AM. Transmission of Methicillin-Resistant *Staphylococcus spp.* from Infected Dogs to the Home Environment and Owners. *Antibiotics (Basel)*. 2022;11(5):637. <https://doi.org/10.3390/antibiotics11050637>
25. van Duijkeren E, Kamphuis M, van der Mije IC, Laarhoven LM, Duim B, Wagenaar JA, et al. Transmission of methicillin-resistant *Staphylococcus pseudintermedius* between infected dogs and cats and contact pets, humans and the environment in households and veterinary clinics. *Veterinary Microbiology*. 2011;150(3):338–343. <https://doi.org/10.1016/j.vetmic.2011.02.012>
26. Julian et al. Methicillin-resistant staphylococcal contamination of cellular phones of personnel in a veterinary teaching hospital. *BMC Research Notes*. 2012;5:193. <https://doi.org/10.1186/1756-0500-5-193>
27. Morris DO, Boston RC, O'Shea K, Rankin SC. The prevalence of carriage of methicillin-resistant staphylococci by veterinary dermatology practice staff and their respective pets. *Veterinary Dermatology*. 2010;21(4):400–407. <https://doi.org/10.1111/j.1365-3164.2010.00866.x>
28. Santana JA, Paraguassu AO, Santana RST, Xavier RC., Freitas PMC, Aburjaile, FF, et. al. Risk Factors, Genetic Diversity, and Antimicrobial Resistance of *Staphylococcus spp.* Isolates in Dogs Admitted to an Intensive Care Unit of a Veterinary Hospital. *Antibiotics*. 2023;12(3):621–636. <https://doi.org/10.3390/antibiotics12030621>
29. Belo L, Serrano I, Cunha E, Carneiro C, Tavares L, Miguel Carreira L, Oliveira M. Skin asepsis protocols as a preventive measure of surgical site infections in dogs: chlorhexidine-alcohol versus povidone-iodine. *BMC Veterinary Research*. 2018;14(1):95. <https://doi.org/10.1186/s12917-018-1368-5>
30. Hur BA, Hardefeldt LY, Verspoor KM, Baldwin T, Gilkerson JR. Describing the antimicrobial usage patterns of companion animal veterinary practices; free text analysis of more than 4.4 million consultation records. *PLoS ONE*. 2020;15(3) <https://doi.org/10.1371/journal.pone.0230049>
31. Chirillo C, Nocera FP, Piantedosi D, Fatone G, Della Valle G, De Martino L, Cortese L. Data on before and after the Traceability System of Veterinary Antimicrobial prescriptions in small animals at the University Veterinary Teaching Hospital of Naples. *Animals*. 2021;11(3):913. <https://doi.org/10.3390/ani11030913>
32. Glavind AS, Kruse AB, Nielsen LR, Stege H. Monitoring antimicrobial usage in companion animals: exploring the use of the Danish VetStat database. *Acta Veterinaria Scandinavica*. 2022;64(1):27. <https://doi.org/10.1186/s13028-022-00647-w>

About the Author:

Ekaterina A. Lavrova, veterinarian, 1st-year intern in the specialty “Dermatology”, Don State Technical University (344003, Russian Federation, Rostov-on-Don, Gagarin Square, 1).

Conflict of interest statement: the author do not have any conflict of interest.

Author have read and approved the final manuscript.

Об авторе:

Екатерина Александровна Лаврова, ветеринарный врач, интерн 1-го года обучения по специальности «Дерматология» Донского государственного технического университета (344003, Российская Федерация, г. Ростов-на-Дону, пл. Гагарина, 1).

Конфликт интересов: автор заявляет об отсутствии конфликта интересов.

Автор прочитал и одобрил окончательный вариант рукописи.

Received / Поступила в редакцию 20.05.2026

Reviewed / Поступила после рецензирования 21.06.2026

Accepted / Принята к публикации 09.07.2026