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Surgical blades as bacteria dissemination vehicles in dogs undergoing surgery – a pilot study

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Abstract: Surgical site infections (SSI) are post-surgical incisional infections in superficial or deep tissues, including organs. Due to their importance in veterinary medicine, the role of surgical blades in bacterial dissemination to internal tissues of dogs undergoing surgery was evaluated. A total of 46 dogs presented for orthopedic or soft tissue surgery in different anatomical regions were included in this study. From each animal two swab samples were collected, from the skin post-asepsis and from the scalpel blade after skin incision, for bacterial growth evaluation in Brain Heart Infusion (BHI) agar and detection of methicillin-resistant species. Results showed that 30.4% (14/46) and 28.3% (13/46) of the post-asepsis and blade samples originated positive bacterial cultures in BHI agar, respectively. However, only 10.8% (5/46) of the positive blade samples also corresponded to a positive post-asepsis sample. Nevertheless, all samples were negative for methicillin-resistant bacteria. Although no dog has developed SSI, the present report showed that the scalpel blade may act as a dissemination vehicle of potential bacterial pathogens to superficial or internal tissues of dogs undergoing surgery, potentially leading to SSI development. Therefore, it is recommended to use a single blade for skin incision and a new blade for the remaining surgical approach, reducing the potential of bacteria dissemination into deeper tissues by the first skin incision blade.

Keywords: dogs; fomites; skin asepsis; surgical blade; surgical site infection.

1. Introduction

According to the Centers for Disease Control and Prevention (CDC), surgical site infections (SSI) can be characterized as infections that develop in the incisional superficial or deep tissues, including organs, of patients' undergoing surgery, occurring in the first 30 days post-procedure [1]. In veterinary medicine, as well as in human medicine, SSI are related with increased morbidity and

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mortality rates, extended hospitalization, and higher healthcare costs [2, 3]. SSI arise after invasive manipulation of superficial, deep tissues, organs, or cavities (Figure 1) [1, 2, 4], and the risk of SSI development increases when there is an external contamination of the surgical site [1, 5, 6] with a concentration of more than 10^5 microorganisms per gram of tissue [1, 5].

Most SSI are caused by microorganisms present on or in the patients' skin, mucous membranes, and hollow viscera, staphylococci being the most frequent bacterial group responsible for SSI in small animals [3]. Among this group, the incidence of methicillin-resistant bacteria, such as methicillin-resistant *Staphylococcus pseudintermedius* (MRSP) and methicillin-resistant *Staphylococcus aureus* (MRSA), is a challenging problem due to their high resistance levels [7], rendering SSI promoted by such bacteria extremely difficult to eradicate. Therefore, pre-surgical skin asepsis is the most important preventive measure aiming to eliminate or strongly decrease the transient microbiota of the animals' skin [8, 9]. Several biocides can be used in this step, povidone-iodine and chlorhexidine being two of the most frequently applied in the veterinary practice [2, 10, 11].

The aim of this study was to evaluate the role of the surgical blade as a transport vehicle of microorganisms to superficial or internal tissues and a potential promoter of SSI in dogs undergoing surgery, independently of the pre-surgical skin asepsis biocide used.

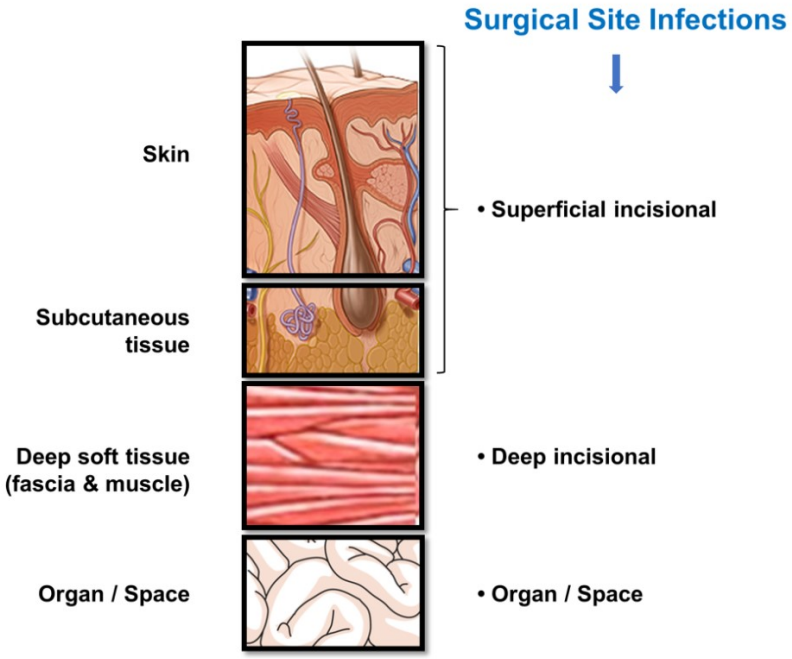

Figure 1. Anatomy of surgical site infections and their classification (adapted from CDC [1]).

2. Materials and Methods

2.1. Samples

A total of 46 dogs presented for orthopedic or soft tissue surgery in different anatomical regions were included in this study, comprising 17 males and 29 females, aged between 7 months and 16.3 years, and weights ranging between 1.8 kg and 38.2 kg (Table 1).

All animals performed pre-surgical exams, including hepatological and biochemical parameters evaluation, namely complete blood count and serum determination of creatinine, urea, glucose, albumin, and hepatic enzymes (alanine aminotransferase, aspartate aminotransferase and alkaline phosphatase), in order to exclude those animals with laboratory standard tests results deviated from the reference values. Of the 46 dogs, 23 were randomly selected to be submitted to a pre-surgery skin asepsis protocol with 7.5% povidone-iodine, and the remaining 23 to a pre-surgery skin asepsis protocol with an alcoholic solution of 2% chlorhexidine, as previously described [12]. Surgical team preparation was performed according to former reports [13, 14].

Table 1. Distribution of the animals included in this study (n=46) according to gender, age average, weight average, type of surgery (orthopedic, abdominal and non-abdominal), and previous exposure to antibiotic therapy.

Canids features	Total
Males (n)	17
Females (n)	29
Age (average in years)	6.6
Weight (average in Kg)	16
Orthopedic surgery (n)	10
Abdominal surgery (n)	24
Non-abdominal surgery (n)	12
Prophylactic antibiotic therapy (n)	46

According to surgical wound classifications identified by CDC [1, 15] all surgically created wounds were clean. Post-surgical evaluation of all dogs was performed by the veterinary surgeon at 24 hours, at day 10, and at day 30 (no implants applied), to access the presence of SSI signs as recommended in the literature [4, 15]. Despite the surgery classification, all animals were submitted to antimicrobial prophylaxis with amoxicillin/clavulanate or cefalexin, according to local clinical proceedings.

2.2. Swab samples

From each animal, one skin swab sample was collected post-asepsis, as described by Belo *et al.* [12]. After transfer to the surgery ward, a second swab sample was collected from the scalpel after skin incision by the veterinary surgeon. All swabs were placed in Amies transport medium (Deltalab) and transported to the Microbiology Laboratory from the Faculty of Veterinary Medicine, University of Lisbon, Portugal, for analysis. All swabs were placed in tubes with 1 mL of sterile saline and homogenized. Then, 100 µL of each suspension were plated onto BHI (VWR) and modified MRSA (CONDA laboratories) agar media. BHI plates were incubated at 37 °C for 48 h, and MRSA plates at 37 °C for 72 h. After incubation, bacterial quantification (CFU/ml) was performed.

The reference strain *Staphylococcus aureus* ATCC 29213 was used as positive and quality control of the MRSA medium.

3. Results and Discussion

Concerning the post-asepsis samples, 30.4% (14/46) originated positive bacterial cultures in BHI agar, with equal distribution regarding the asepsis protocol. Bacterial counts ranged from 10 to more than 10^9 CFU/mL with 3 samples showing more than 10^5 CFU/mL.

Blade swab samples from 28.3% (13/46) of all animals originated positive bacterial cultures in BHI agar after incubation. From the positive samples, 26.1% (6/23) were collected from blades used in animals submitted to the povidone-iodine asepsis protocol, while 30.4% (7/23) were obtained from animals from the chlorhexidine group. Bacterial counts ranged from 10 to more than 10^9 CFU/mL, with five of the positive blade samples showed more than 10^5 CFU/mL. It is important to refer that only 10.8% (5/46) of the positive blade samples also corresponded to positive post-asepsis samples.

None of the swabs presented bacterial growth in modified MRSA.

It is important to refer that in our study none (0/46) of the individuals presented signs of SSI, either at 24 hours or at 10 and 30 post-operative day, revealing that the antimicrobial prophylaxis protocols established were effective.

It was possible to demonstrate that the scalpel blade can act as a fomite for bacteria, having the potential of transporting them into superficial or deeper tissues below the surgical site incision.

The detection of 30.4% (14/46) positive post-asepsis samples reinforce the already described possibility of incomplete bacterial skin elimination during the pre-surgical asepsis [13]. The fact that it was possible to detect bacteria in BHI in 17.4% of the surgical blade swabs but not in the post-asepsis swabs may result from scalpel contamination via surgeon hands or surgical gloves. According to a recent study by Anderson *et al.* [9], the post-asepsis

contact between the non-properly sterilized hands of the surgeon and the surgical site occurs in at least 36% of the cases, being also observed that the external contamination of sterile surgical gloves happens occasionally. In addition to external contamination by surgical gloves, losses through gloves and their perforation during surgical procedures may also occur. In two pet hospitals, it was observed that gloves perforation during surgical procedures occurred in 38.7% of the cases without being detected [9]. As such, the asepsis of the hands prior to the surgical procedure remains critical and extremely important, being an important measure to reduce SSI frequency, likewise the use of two gloves, exchange of gloves during long procedures, and the establishment of prophylactic antibiotic therapy [16].

Positive culture results obtained from blade swabs may also result from the presence of viable bacteria in deeper epidermal layers or skin adnexal structures that are not eliminated by standard methods of surgical skin preparation, and with which the scalpel blade might get in contact during skin incision.

Considering the positive blade swabs, there was no statistical difference between the ones used in the two groups under study, confirming previous results sustaining that both pre-surgical asepsis protocols show similar efficacy in reducing the total load of skin bacteria, including methicillin-resistant strains in dogs undergoing surgery [10-12]. This was confirmed by the fact that all samples were negative in MRSA medium.

According to Mangram *et al.* [1], if the surgical site is contaminated with more than 10^5 microorganisms per gram of tissue, there is a markedly increased risk of SSI development. In our study, 6.5% (3/46) of the post-asepsis samples and 10.9% (5/46) of the blade samples revealed bacterial loads higher than 10^5 CFU/mL. Therefore, despite the effective asepsis protocols used, skin remains a source of bacteria that can colonize the blade and deeper tissues during surgery, demonstrating the importance of using a single blade for skin incision and a new/second blade for the remaining surgical approach, reducing the potential of bacteria dissemination into deeper tissues by the initial skin incision blade.

4. Conclusions

To our knowledge, this is a leading study aiming at confirming the role of the scalpel blade as a potential dissemination vehicle of microorganisms to superficial or internal tissue of dogs undergoing surgery, by evaluating bacterial growth from the skin sample at post-asepsis and from the scalpel blade after skin incision. Scalpel blades may be fomites for potential pathogens and, as such, may be responsible for SSI.

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Conflicts of Interest

The authors declare no conflict of interest.

The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Ethics approval

All animals were cared for according to the rules given by the current EU (Directive 2010/63/EC) and national (DL 113/2013) legislation and by the competent authority (Direção Geral de Alimentação e Veterinária, DGAV, http://www.dgv.min-agricultura.pt) in Portugal. Only non-invasive samples were

collected during routine procedures with consent of owners, and no ethics committee approval was needed. Trained veterinarians obtained all the samples, following standard routine procedures. No animal experiment has been performed in the scope of this research.

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