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Review

Canine superficial bacterial folliculitis: Current understanding of its etiology, diagnosis and treatment

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ABSTRACT

Superficial bacterial folliculitis (SBF) is more common in the dog than other mammalian species. Until recently, a successful outcome in cases of canine SBF was possible by administering a potentiated amoxicillin, a first generation cephalosporin or a potentiated sulfonamide. Unfortunately, this predictable susceptibility has changed, because methicillin resistant *Staphylococcus pseudintermedius* (MRSP) and *Staphylococcus aureus* (MRSA) are becoming more prevalent in canine SBF cases. The increasing frequency of multidrug resistance complicates the selection of antimicrobial therapy. Antimicrobial agents that were once rarely used in cases of canine SBF, such as amikacin, rifampicin and chloramphenicol, are becoming the drugs of choice, based on bacterial culture and susceptibility testing. Furthermore, changes in antimicrobial susceptibility have helped to re-emphasize the importance of a multimodal approach to treatment of the disease, including topical therapy. Due to the increasing frequency of identification of highly resistant *Staphylococcus* spp., topical antimicrobial therapy, including the use of diluted sodium hypochlorite (bleach), is becoming necessary to successfully treat some cases of canine SBF. Other important antiseptics that can be used include chlorhexidine, benzoyl peroxide, ethyl lactate, triclosan and boric acid/acetic acid. This review discusses the diagnostic and therapeutic management of canine SBF, with a special emphasis on treating methicillin resistant staphylococcal infections.

Introduction

Bacterial pyoderma is more common in the dog than other mammalian species. In contrast to *Staphylococcus aureus* infections in human beings, virulence factors, such as protein A, leukocidin, hemolysins and epidermolytic toxin, have not been shown to play a role in the pathogenesis of canine pyoderma. Numerous studies have failed to identify any differences in toxin profiles between *Staphylococcus* spp. from normal dogs and those from dogs with pyoderma (Allaker et al., 1991). Since *Staphylococcus pseudintermedius*, the most common organism that causes canine pyoderma, is a normal commensal of the dog, it appears that abnormal 'host factors' are the primary cause of these infections. The most common primary causes include hypersensitivities, ectoparasites, endocrinopathies and cornification abnormalities. Long term success in treating canine bacterial pyoderma requires identifying and treating the primary cause.

Bacterial pyoderma can be classified on the basis of the depth of the lesion(s). The different classifications are (1) surface pyoderma (pyotraumatic dermatitis, mucocutaneous pyoderma and skin fold dermatitis); (2) superficial bacterial folliculitis (SBF); and (3) deep pyoderma, namely, deep folliculitis and furunculosis, and cellulitis (subcutaneous involvement). This review article is focused on superficial bacterial infection of the hair follicle (folliculitis). It is beyond the scope of this article to completely review canine SBF and the objective is to provide an update on the disease in dogs, especially in regards to methicillin resistance.

Etiology

Historically, *Staphylococcus intermedius* had been the most commonly isolated pathogen in dogs with SBF (Cox et al., 1984; Medleau et al., 1986). More recently, microbiologists have shown that all the organisms identified in the past as *S. intermedius* were really *S. pseudintermedius* (Devriese et al., 2005). This has been modified further, such that there is now a *Staphylococcus intermedius* group (SIG) with members including *S. intermedius*, *S. pseudintermedius* and *S. delphini*.

S. pseudintermedius remains the organism most commonly causing SBF in dogs (Sasaki et al., 2007). However, for clinicians, these name changes have no bearing on the medical management of the cases. What is important is to differentiate SIG from the bacterium that causes human infections, i.e. *S. aureus*. SIG can be differentiated from *S. aureus* based on a variety of different techniques, including phenotypic testing or molecular identification

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using whole-cell fingerprinting by matrix-assisted laser desorption–ionization (MALDI)-time-of-flight mass spectrometry (MS), biochemical features, DNA–DNA hybridization and PCR (Dubois et al., 2010; Sasaki et al., 2010).

Staphylococcus schleiferi has also been associated with bacterial pyoderma. *S. schleiferi* may be either coagulase positive (*S. schleiferi coagulans*) or coagulase negative (*S. schleiferi schleiferi*) (Frank et al., 2003). In the past, coagulase negative staphylococci were considered to be contaminants when found on a culture from a superficial lesion in a dog. However, coagulase negative *S. schleiferi schleiferi* is a pathogen that is potentially zoonotic. For this reason, it is important that laboratories identify coagulase negative staphylococci down to the species level (for example, to differentiate non-pathogenic *S. epidermidis* from pathogenic *S. schleiferi schleiferi*).

Clinical signs

Pruritus in dogs with SBF ranges from non-existent to intense. Clinically, SBF presents differently in different breeds of dogs. Most dogs have multifocal areas of alopecia, follicular papules or pustules, epidermal collarettes and serous crusts involving the trunk, abdomen and axillary areas. Short-coated breeds often present with a 'moth-eaten' appearance to the hair coat due to alopecic lesions associated with the folliculitis. Cocker spaniels have their own special presentation, i.e. vegetative plaques, which are frequently mistaken for seborrheic plaques associated with primary seborrhea of Cocker spaniels. Clinically and histopathologically, they can be quite similar; therefore, if plaques are found on a Cocker spaniel, the dog should be treated for a bacterial pyoderma before assuming that the dog has 'idiopathic seborrhea'. The diagnosis of SBF is usually based on physical signs (i.e. multifocal areas of alopecia, papules, pustules and epidermal collarettes), supported by cytology and/or bacterial culture.

Diagnosis

Investigation of the underlying cause of the disease should be performed because primary canine bacterial pyoderma does not occur. When a dog is presented for the first time with SBF, only a limited number of diagnostic tests need to be undertaken. However, with recurrent or chronic cases of SBF, or with any dog with a deep bacterial pyoderma, there is a need for the underlying cause to be pursued aggressively.

The predisposing causes of SBF include: (1) hypersensitivities (atopy, cutaneous adverse food reactions, flea allergy dermatitis); (2) ectoparasites (e.g. *Sarcoptes* spp.); (3) endogenous (hyperadrenocorticism) or exogenous exposure to corticosteroids; (4) demodicosis (*Demodex* spp.); (5) hypothyroidism; (6) follicular dysplasias (e.g. color dilution alopecia); (7) ectodermal dysplasia (e.g. Chinese crested dogs); and (8) cornification abnormalities (sebaceous adenitis, ichthyosis) (Mason and Lloyd, 1989; Chesney, 2002).

Cutaneous cytological examination

Cutaneous cytology is an easy, inexpensive and rapid diagnostic test that should be performed on any dog that is presented with skin lesions. There are a variety of methods to collect cytology specimens (Mueller, 2000), with each method having advantages and disadvantages. Cytology is used to identify the presence (and/or type) of: (1) bacterial or fungal organisms (e.g. *Malassezia*); (2) neoplastic cells; (3) inflammatory cells; and (4) abnormal cells (e.g. acantholytic keratinocytes associated with pemphigus foliaceus). When evaluating cutaneous cytology specimens for infection, a semiquantitative scale ranging from 0 to 4+ should be used (Budach and Mueller, 2012).

Bacterial culture

Bacterial culture may be necessary when managing a case of SBF. Before culturing a lesion, cutaneous cytology should be performed on a representative lesion to confirm the presence of bacterial infection (neutrophils with intracellular bacteria). Bacterial culture and susceptibility (c/s) testing should always be performed in poorly responsive SBF cases, but is not necessary in antimicrobial responsive but recurrent cases, since these cases will mostly benefit from identifying and treating the primary cause only. Since Gram negative, rod shaped bacteria isolated from the skin are frequently resistant to many antibacterial agents (Petersen et al., 2002), a bacterial culture should be submitted if neutrophils and rod-shaped bacteria are identified on cutaneous cytology.

If a culture and susceptibility test is submitted, the minimum inhibitory concentration (MIC) broth microdilution technique rather than the disc diffusion method should be used to determine susceptibility. The disc-diffusion susceptibility test (DDST) is semiquantitative in that the drug concentration achieved in the agar surrounding the disc can be roughly correlated with the concentration achieved in the dog's serum. It will only report the organism's susceptibility (susceptible, intermediate or resistant, SIR) based on an approximation of the effect of an antimicrobial agent on bacterial growth on a solid medium. Tube dilution (MIC) is quantitative, not only reporting SIR, but also the amount of drug necessary to inhibit microbial growth. The MIC is reported as the lowest concentration of an antimicrobial agent (in μg/mL) necessary to inhibit visible growth of the tested bacteria. This allows a clinician to decide on, not only susceptibility or resistance, but also the proper dosage and frequency of administration of the antimicrobial agent. The MIC method can imply the relative risk of emerging resistance and thus the need for a high treatment dose.

Samples from a pustule or intact nodule should be used for culturing, but if an intact pustule or papule is not available, culturing an epidermal collarette has also been shown to be reliable for sampling for SBF (White et al., 2005). Submitting a crust is also useful for a dog with SBF if any of the classical lesions are not present; culture results from the crust are the same as those from a macerated tissue punch biopsy sample (Vaughan and Lemarie, 2008).

Systemic treatment

Recently, successful treatment of SBF could be accomplished predictably with a β-lactam antibiotic (a first generation cephalosporin, such as cephalexin, or a potentiated amoxicillin). However, increasingly methicillin resistant *Staphylococcus* spp. (MRS) are being identified as causes of skin infections in dogs. MRS may be *S. aureus* (MRSA), *S. pseudintermedius* (MRSP), *S. intermedius* (MRSI) or *S. schleiferi* (MRSS). No member of the β-lactam family of antibiotics will be effective when MRS is identified.

The incidence of MRSP has been increasing over the last decade, rendering many commonly used antibacterial agents ineffective (Jones et al., 2007). An additional complication is that these bacteria are frequently multi-drug resistant (MDR). In a recent study, >90% of MRSP were MDR, defined as being resistant to $\geqslant$4 antimicrobial drug classes (Bemis et al., 2009).

The cause of the increased frequency of MRSP has not been clearly established, but one of the many risk factors for MRSA and MDR *Staphylococcus* spp. is the administration of fluoroquinolones. Reducing the use of antimicrobial agents and, particularly, fluoroquinolones and third generation cephalosporins, may help to prevent persistent carriage of MRSA in human beings (Monnet, 1998; Muto et al., 2003). Fukatsu et al. (1997) reported MRSA outbreaks in human beings in a hospital that were correlated with