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REVIEW ARTICLE

Facial Dog Attack Injuries

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Abstract The exposed position of the face makes it vulnerable to dog bite injuries. This fact combined with the short stature of children makes them a high-risk group for such attacks. In contrast to wounds inflicted by assaults and accidents, dog bite wounds are deep puncture type wounds compounded by the presence of pathologic bacteria from the saliva of the attacking dog. This, combined with the presence of crushed, devitalized tissue makes these wounds highly susceptible to infection. Key to successful management of such wounds are meticulous cleansing of the wound, careful debridement, primary repair, appropriate antibiotic therapy, and rabies and tetanus immunization where indicated. This review presents an overview of the epidemiology, presentation, management of such emergencies, and the recent advances in the care of such patients.

Keywords Dog bite · Facial wound · Management · Bite wound · Complications

Introduction

Facial bite injuries hold a special position in maxillofacial trauma care due to their propensity to get infected compared to similar soft tissue wounds caused by other reasons [1]. Mammalian bite injuries account for 10 % of patients presenting with soft tissue injuries to the orofacial region [2] and dog bites account for 90 % of these injuries [3]. The most common issue with such injuries is the direct physical injury, not uncommonly the injuries may cause permanent disfigurement of the victims requiring reconstructive surgery, psychological trauma, post-traumatic stress, and rarely attacks can be fatal [4].

Although most dogs never bite a human, under special circumstances, any dog is capable of inflicting harm. Children are the most common victims of dog bites due to their short stature especially in incidents that prove fatal [5]. The highest incidence of bites occurs in boys 5–9 years of age [5]. Almost one half of all reported cases of dog bites involve an animal owned by the victim's family or the victim's neighbors [5]. Several dog breeds have been identified for their role in fatal dog bite attacks, including pit bull breeds, malamutes, chows, Rottweilers, huskies, German shepherds, dobermans, and wolf hybrids [5].

The location of injury due to dog bites is largely dependent on age. In younger children, the most frequently affected areas are the head, face, and neck. As the child grows, bites to the extremities are most common [6].

A canine oral cavity contains more than 1,000 species of pathogenic bacteria due to which its bite wounds are generally contaminated, and their treatment is difficult because of the risk of infection, especially in extensive injuries [7]. The risk of development of rabies and tetanus further complicates the picture in the care of such patients. About 3 to 20 % dog bite wounds develop infections [7].

Classification of Dog Bite Victims

GROUP 1 Victim presents within 8–12 h of the incident with fears of contracting rabies or other infections and/or with concerns of permanent disfiguration of the injured body part. These wounds are often contaminated with bacteria but do not show evidence of infection [8].

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GROUP 2 Victim presents more than 12 h after the incident, most often presenting with signs and symptoms of developing infections [8].

Clinical Features and Pathogenesis

Dog bites are generally associated with soft tissue injury to the face but rarely result in facial fractures. When soft tissues are involved, the lips, nose, and cheeks comprise the central "target area." When facial bone fractures are involved, the most common are orbital and nasal bones [9]. Lacerations are the most frequently associated soft tissue injury. Additional injuries may include facial nerve damage, lacrimal duct damage, ptosis from levator transection, and blood loss requiring transfusion [9]. Lackmann et al. has classified facial wounds based on their extent [10]. Table 1

In patients presenting after 12 h of the attack, signs of secondary infection may have developed in the form of wound site pain with cellulitis and purulent drainage [11]. Other complications that may develop are lymphangitis, local abscess, septic arthritis, tenosynovitis, and osteomyelitis. Rare complications include endocarditis, meningitis, brain abscess, and sepsis with disseminated intravascular coagulation, especially in immunocompromised individuals [12].

Dog bites tend to cause lacerations, with crush and avulsion injuries as a result of the large, broad, sharp teeth and powerful jaws [13]. The force transmitted by a dog jaw can be as high as 450 lbs/sq in. [13]. Most infections from animal bites develop at the site of the bite wound and adjacent tissue. Among the various wound types, puncture wounds have the highest incidence of infection due to the narrow entry point and poor drainage. Further, puncture wounds tend to seal quickly, producing an environment that facilitates growth of anaerobic organisms, especially in the deeply inoculated tissues [13].

Several risk factors for bite wound infection have been reported [14] (Table 2).

Microbiology of Dog Bite Wounds

Most infections caused by dog bites are polymicrobial, with mixed aerobic and anaerobic species [15]. Bacteriology of infected dog bite wounds includes aerobes *Pasteurella multocida*, *Pasteurella canis*, *Staphylococcus aureus*, *Viridans streptococci*, *Capnocytophaga canimorsus*, *Bacillus suppuratus*, *Actinomyces suppuratus*, and oral anaerobes *Prevotella*, *Clostridium*, and *Peptostreptococcus* [15]. A case of isolation of *C. canimorsus* from a dog bite wound has been reported [15].

Table 1 Lackmann classification of head and neck bite wounds

Stage	Clinical appearance
I	Superficial injury without involvement of muscle
II	Deep injury with involvement of muscle
III	Deep injury with involvement of muscle and tissue defect
IVA	Stage III in combination with vascular nerve injury
IVB	Stage III in combination with bony involvement or organ defect

Table 2 Risk factors associated with a high rate of infection of dog bite wounds

Age: <2 and >50 years
Comorbidities (liver disease, splenectomy, diabetes mellitus, malignancy, HIV, vascular disease)
Pre-existing edema in the area of bite
Chronic alcohol consumption
Use of immunosuppressive drugs (including chronic steroids)
Moderate to severe wounds
Puncture wound, large avulsion, crush injury
Presence of foreign material and/or heavily contaminated wound
Scalp or face in infants and young children
Associated injuries to bone, joint, tendon sheath, or neurovascular structures
Adjacent to prosthetic joint
Delay in care >24 h
Improper wound cleansing or debridement

Management

The recommended protocol in management of facial dog bite wounds is detailed in Table 3. First-line antimicrobial prophylaxis for high-risk dog wounds in healthy patients is amoxicillin–clavulanate for 3 to 5 days [16]. Alternatively, ampicillin–sulbactam might be given intravenously if the patient is unable to take oral antibiotics. If the patient is allergic to penicillin, first-line treatment is an extended-spectrum cephalosporin or trimethoprim–sulfamethoxazole plus clindamycin [16]. The duration of prophylaxis should be 3–5 days while infected wounds need to be covered with 7–14 days of antibiotic cover [16]. A major wound infection is defined as fever (over 38 °C), lymphangitis, abscess, or at least four or five minor criteria—erythema, tenderness, swelling at the wound site, purulent

Table 3 Protocol for management of facial dog bite injuries

Take a detailed medical history and confirm patient's medical fitness.
Document the etiology of the injury along with photographic records.
Bite wounds must be examined carefully for secondary injuries to the facial nerve, blood vessels, tendons, lacrimal or parotid ducts, and bones, as well as ischemia must be ruled out.
Depending on the extent and the location of the injury, the patient should undergo radiological diagnostics (CT/MRI) to make sure no foreign bodies (teeth, food) remain in the wound and to investigate possible bone injuries, particularly relevant for the detection of cranial injuries in a child.
Consider the use of general anesthesia for younger patients to improve the quality of initial care.
Prophylactic antibiotics must be administered where the risk of infection is high and where primary closure is being considered.
Remove visible dirt, perform copious irrigation, culture wounds (if they appear infected), and debride devitalized tissue.
Non-infected facial wounds of less than 24 h duration should be primarily repaired.
Wounds >24 h duration, large crush wounds, puncture wounds, and wounds with devitalized tissue must be observed for 2–3 days, re-evaluated, and managed with delayed primary repair or healing by secondary intention.
Patients should be assessed for tetanus immunization status and treated with immunization or immunoglobulins if necessary.
Rabies vaccination/immunoglobulin administration where indicated.

discharge, and leukocytosis of more than 12×10^9/L [17]. Adequate debridement is known to decrease the infection rate in dog bite wounds by eliminating crushed or devitalized tissue which would otherwise serve as a nidus of infection [18]. However, puncture wounds are difficult to debride. Thorough irrigation with an irrigant solution is thought to reduce bacterial load, remove particulate matter, and reduce infection rate [18]. Concentrated forms of povidone-iodine, hydrogen peroxide, or ethyl alcohol should not be used as irrigating solutions because they can cause tissue damage and toxicity [19]. Alternatively, povidone-iodine and ethanol mixture should be diluted with saline and used because both the alcohol and the iodine penetrate into the tissue quickly and can take effect [20, 21]. However, solvents containing alcohol may cause severe burning sensations when applied and therefore sensitive patients (e.g., children) might require local anesthesia. Should the patient suffer from thyroid gland dysfunction or a known iodine allergy, an ethanol based skin antiseptic may be an alternative.

Table 4 Tetanus prophylaxis after dog bites

History of absorbed tetanus toxoid (doses)	Tetanus prophylaxis	
	Td	TIG
<3 or unknown	Yes	Yes
≥3	No[a]	No

Adapted from the American Academy of Pediatrics [25]

Td tetanus–diphtheria toxoids; *TIG* tetanus immune globulin

[a] Yes if ≥5 years since last dose

Some authors recommend normal saline as the preferred irrigant for dog bite wounds as it does not interfere with wound healing in contrast to povidone-iodine or ethanol [22]. It remains to be determined whether an attempt should be made to irrigate bite puncture wounds as their small cutaneous openings do not permit the solution to drain out adequately and attempts at irrigation may in fact result in infiltration.

Table 5 Guidelines for rabies immunization

Vaccination status	Treatment	Regimen[a]
Not previously vaccinated	RIG	Administer 20 IU/kg body weight. If anatomically feasible, the full *dose* should be infiltrated around the wound(s) and any remaining volume should be administered IM at an anatomic site distant from vaccine administration. Also, RIG should not be administered in the same syringe as vaccine. Because RIG may partially suppress active production of antibody, no more than the recommended dose be given.
	Vaccine	HDCV, RVA, or PCEC 1 mL, IM (deltoid area[b]), once daily on days 0[c], 3, 7, 14, and 28
Previously vaccinated	RIG	RIG should not be administered[d].
	Vaccine	HDCV, RVA, or PCEC 1.0 mL, IM (deltoid area[b]), once daily on days 0[c] and 3

RIG rabies immune globulin; *IU* immunizing unit; *IM* intramuscularly; *HDCV* human diploid cell vaccine; *RVA* rabies vaccine adsorbed; *PCEC* purified chick embryo cell vaccine

[a] These regimens apply to all age groups including children

[b] The deltoid area is the only acceptable site of vaccination for adults and older children. For younger children, the outer aspect of the thigh may be used. Vaccine should never be administered in the gluteal area

[c] Day 0 is the day the first dose of vaccine is administered

[d] Any person with a history of pre-exposure vaccination with HDCV, RVA, or PCEC prior post-exposure prophylaxis with HDCV, RVA or PCEC, or previous vaccination with any other type of rabies vaccine and a documented history of antibody response to the prior vaccination

Non-infected facial wounds less than 24 h old can probably be primarily repaired [11, 23]. Facial wounds can be closed with high rates of success, probably due to the high vascularity and absence of dependent edema. Subcutaneous sutures should be kept to a minimum as they can act as foreign bodies and can precipitate infection. Avulsive injuries with significant tissue loss represent the most difficult cases for definitive management [17]. Traumatic avulsion involving the lip vermilion and the perioral composite soft tissue, even with injuries including delicate anatomic landmarks, healing by secondary intention can be instituted as the initial treatment of choice in younger patients often providing optimal results [24]. Large avulsive wounds with tissue loss where primary repair is not possible can be managed with local or regional flaps, skin grafts, or microvascular reconstruction [22].

Tetanus immunization status must be evaluated and treated with immunization or immunoglobulin administration was indicated [25] (Table 4). Rabies is a dreaded complication of dog wounds due to its 100 % fatality rate. It is caused by Rhabdoviridae, an RNA virus with an incubation period of 20–40 days in humans and shorter in dogs [26]. Disease progression is characterized by the prodromal phase, encephalitis, and brain stem center dysfunction. In the final stages, spasm of the muscles of deglutition leads to the classical clinical presentation of "foaming mouth" [22]. Finally, complete paralysis, coma, and respiratory distress lead to death. Deciding upon the need for prophylaxis depends upon the circumstances surrounding the attack (like whether it was provoked or not), the regional incidence of rabies, and whether the dog was vaccinated or not [22]. Every effort must be made to capture the offending dog. If rabies is suspected during an observational period of 10 days, the dog is killed and a brain specimen is sent for fluorescent antibody test to demonstrate intracytoplasmic "Negri bodies" [22]. When capture is not possible or history of dog vaccination is unavailable, the victim must receive rabies prophylaxis [27]. Guidelines for rabies immunization [27] are presented in Table 5.

Conflict of Interest None

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