Management of Human and Animal Bites

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KEYWORDS

• Face • Animal bites • Human bites • Infection • Scarring • Cosmetics • Dog bite

KEY POINTS

- Dog bites are the most common facial animal bites.
- These wounds have a significant infection potential.
- The management includes not only surgical but also medical management.
- Management of animal and human bites is individualized based on each case.
- Dogs are the animal most frequently implicated in causing bite injuries to the human face.
- The oral flora of the animal that inflicts the bite or bites is a factor and has implications for management.
- Each species of animal has a relatively unique oral microbacterial flora, which has implications for the potential infection risk and the management of a wound.
- Bite wounds tend to result in 3 broad categories of injury: puncture wounds, lacerations, and tissue avulsion injuries.
- Dog bites tend to result in more lacerations and avulsive-type injuries.
- Cat bites tend to be more puncture-type wounds.
- Human bites to the face more commonly involve the ear, but the lip and nose also are sites with a higher incidence of human bite injury.

INTRODUCTION

The human face is a cosmetically and overly sensitive area, which is a critical component in our daily human interactions with others. Trauma to the facial tissues has immense social, psychological, and functional ramifications. Human and animal bites to the face tend to result predominantly in isolated soft tissue injury, but this soft tissue injury wound tends to be ragged and more prone to unfavorable scarring. The oral flora of the animal that inflicts the bite or bites is a factor and has implications for management. Most animal bites sustained by humans occur to the extremities, with less than 20% involving the face.[1] Dogs and to a lesser extent cats tend to be the most frequently involved animal in delivering the bite to humans in the developed world, but other animals, such as monkeys, horses, camels, bears, wild boars, rodents, sheep, pigs, snakes, fish, and crocodiles, have been documented in biting humans.[2] The importance of this is that each animal has a characteristic tooth shape and format that ultimately has an influence on the degree and type of injury. Each species of animal has a relatively unique oral microbacterial flora, which has implications for the potential infection risk and the management of a wound. Following dogs and cats, humans tend to be the third most common source of a bite injury to a fellow human. Unlike the above listed animals, a human bite has the potential to be used

The authors have no conflicts of interest to declare.

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Oral Maxillofacial Surg Clin N Am 33 (2021) 373–380
https://doi.org/10.1016/j.coms.2021.04.006

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to identify the aggressor based on forensic dentistry.

EPIDEMIOLOGY

With regards to public health, an estimated 2% of the population is bitten each year.[3] Animal bites are more prevalent in men and boys. With regards to cat and dog bites, there tends to be a sex predilection with regards to the human that sustains the bite injury. Women and girls are most likely to be bitten by cats, whereas men and boys tend to be bitten mostly by dogs. Dogs account for most facial bite wound injuries. The age of the human victim is also a factor to consider. Animal bites to the face are far more common in children than adults, with approximately 10% of bites involving the head and neck in adults compared with approximately 75% in children.[4] The reasoning behind this is that children tend to have less well-developed motor skills with which to defend themselves with their extremities. Children also tend to have larger heads with respect to their bodies, consequently making it a larger target. Last, children are less likely to be able to recognize the emotional behavior of animals, and as a result, do not appreciate the danger and may be more prone to provoking the animal.

WOUND CHARACTERISTICS AND CLASSIFICATION

Bite wounds tend to result in 3 broad categories of injury: puncture wounds, lacerations, and tissue avulsion injuries. Dog bites tend to result in more lacerations and avulsive-type injuries. Dog bite wounds are generally ragged and can have a component of crush injury. The breed of dog inflicting the injury also has an effect on the resulting wound. Pit bulls, terriers, and rottweilers tend to result in more ragged and avulsive injuries because of their dental arrangement. These dogs also tend to have a more forceful bite, with some estimating the potential bite force to be up to 450 pounds per square inch.[5] A retrospective analysis of facial dog bites at a US trauma center showed bite wounds of some breeds of dogs were generally managed with direct repair, but other breeds, such as those noted above, tended to require reconstruction as part of the management of the dog bite injury.[6] This force is potentially strong enough to cause fractures of the human skeleton, especially in a child, and has the potential to cause death if inflicted on the skull. Dog bite injuries inflicted on the neck can be particularly serious, as airway damage with subsequent asphyxiation or great vessel injury with subsequent exsanguination is possible. Dog bites of the face tend to involve lips, nose, and cheek anatomic areas. Cat bites tend to be more puncture-type wounds. Cat bites tend to have a higher incidence of infection because of the penetrating nature of the injury and the microbiology of the cat oral cavity. Human bites to the face more commonly involve the ear, but the lip and nose also are sites with a higher incidence of human bite injury. To aid communication and to allow better assessment of outcomes with respect to varying facial bite wound injuries, Lackmann and colleagues[7] introduced a classification based on facial dog bit wound injuries in children, as shown in **Table 1**. The severity of bite wounds should be assessed, and a determination should be made if the bite wound is a high-risk bite wound. High-risk bite wounds generally require more urgent attention and have the potential to lead to significant complications. High-risk bite wounds include full-thickness puncture wounds, severe crush injury accompanying the bite injury, cat bite wounds, and bite wounds that involve bone, joint, tendon, and/or

Table 1
Classification of facial bite wound injuries

Type	Clinical Findings
I	Superficial injury without muscle involvement
IIA	Deep injury with muscle involvement
IIB	Full-thickness injury of the cheek or lip with oral mucosal involvement
IIIA	Deep injury with tissue defect
IIIB	Deep avulsive injury exposing nasal or auricular cartilage
IVA	Deep injury with severed facial nerve and/or parotid duct
IVB	Deep injury with concomitant bone fracture

ligament.[8] Facial bite wounds in of themselves are generally considered high risk without any of the above features though.

MICROBIOLOGY

The microbiology of animal bite wounds is polymicrobial. This polymicrobial wound environment is composed of a broad mixture of aerobic and anaerobic organisms. Commonly involved aerobic species include *Neisseria*, *Corynebacterium*, and *Staphylococcus*. Anaerobes most frequently implicated in animal bite wounds include *Fusobacterium*, *Bacteroides*, *Prevotella*, *Propionibacterium*, *Peptostreptococcus*, and *Porphyromonas*.

Focusing on the specifics of dog and cat bites, *Pasteurella* species, which is a gram-negative aerobic species and present in the oropharynx of most dogs and cats, is frequently implicated in dog and cat bite wound infections.[9] *Pasteurella canis* is found in 50% of dog bite wounds. *Pasteurella multocida* is found in approximately 30% of dog bite wounds and in approximately 50% of cat bite wounds. *Pasteurella* species bite wound infection can cause cellulitis in humans if not managed appropriately, and this can progress to purulent discharge, fever, osteomyelitis, septic arthritis, and ultimately, septicemia with its consequences if left unchecked.

Human bite wounds also tend to be polymicrobial. *Eikenella corrodens*, which is a normal commensal of the human oral cavity, appears to be particularly prevalent with respect to human bite wound infections. *Viridans streptococci* and *Streptococcus anginosus* tend to be relatively prevalent in human bite wound infections. In general, the aerobic and anaerobic organisms found in dog and cat bites tend to be otherwise similar in human bites with the exception of the *Pasteurella* species. A more worrisome point to consider with human bite injuries is the possibility of hepatitis B, hepatitis C, and HIV infection. These infections can be transferred from the human delivering the bite to the victim, especially if gingival trauma occurs to the person delivering the bite with resultant release of their blood, which can gain access to the victim. Consideration has to be given in human bite wound injuries for the potential of these microorganisms infecting the victim.

With animal bite wounds, the potential for rabies must be considered. Postexposure prophylaxis for rabies is essential and can prevent rabies in humans, which is currently untreatable. Postexposure prophylaxis consists of local wound treatment with washouts and cleaning of the wound followed by vaccination. Consideration should be given to the administration of rabies immune globulin dependingt on the type of exposure and the suspicion for being bitten by an animal suffering from rabies. The use of vaccination in conjunction with rabies immune globulin is essentially 100% effective in preventing human infection if inoculated by a bite from a rabies virus effected animal.

EVALUATION

Initial evaluation should focus on the principles of Advanced Trauma and Life Support (ATLS). Establishment of a defined airway and control of any hemorrhage are of particular importance and are relevant in pediatric patients. As part of the secondary survey, evaluation should be performed for any penetrating intracranial injuries that may result in a pediatric patient owing to their relatively less mineralized calvarial bones. Neurologic function should be assessed. With regards to the face, particular reference to facial nerve function and the sensory nerve function should also be evaluated and documented.

History and physical examination are of primary importance. As part of the history, documentation should be made of the timeline since the bite injury occurred. Ideally, patients with bite injuries to the face should be seen as soon as possible given that early management of the injury reduces the likelihood of infection. Bite injuries seen within 6 hours and managed appropriately have a lower risk of wound infection compared with those seen in a delayed fashion.[10] Animal bite wounds to the extremities are generally left open to reduce the risk of infection. With regards to the face, this is generally avoided to minimize the cosmetic impact of the injury. Bite wounds of the face seen and treated up to 48 hours after the injury with suturing have an acceptably low risk of infection but benefit from potential cosmetic benefits of suturing. There are advocates for suturing closed facial bite wounds presenting in a delayed fashion 48 hours or more after the injury.[11] On review of the patient's past medical history, one should pay particular attention to any conditions that may indicate an immunocompromised patient. Specific questions regarding the presence of diabetes, excessive alcohol consumption, a patient who is a transplant recipient, or a patient taking immunosuppressive drugs for autoimmune conditions should be elicited. The patient should be questioned on the use of tobacco with particular reference to smoking tobacco. This risk factor predisposes the patient to poor healing and an increased risk of infection.

As part of the clinical examination, any signs of infection should be documented, including but

not limited to erythema, purulent drainage, or systemic signs of infection. With regards to the perioral and periorbital tissues, a clear description of the wound should be placed in the medical record. Any avulsed tissue should be noted with an accurately measured wound defect size obtained for the medical records. Medical photography can be invaluable in recording the injury. Injuries involving the perioral and periorbital tissues are high-risk injuries and put the patient at significant risk of cosmetic and functional impairment. Photodocumentation can also be very important in animal and human bite injuries, as these cases often have litigation consequences.

To aid proper assessment of the wound, any dried coagulation tissue or foreign body should ideally be removed with gentle saline irrigation. Excessive scrubbing should be avoided as part of the initial examination. To complete the examination, consideration should be given to radiological investigation. If there is any suspicion for fracture of the facial skeleton, strong consideration should be given to computed tomographic examination. If there is a concern for foreign body within the soft tissue, plain films may be suitable. Once a complete clinical, and if relevant, radiological examination, is completed, a discussion should be had with the patient with regards to their potential treatment options.

Surgical Management

All bite wound injuries should at least be irrigated with normal saline. There is minimal to no extra benefit in the addition of povidone iodine or hydrogen peroxide. Pulsed lavage also does not seem to be merited in most animal bite wound infections to the human face. Given the importance of facial cosmesis, facial bite wounds merit primarily closure with suturing if possible. In the process of primary closure, placement of deep sutures should be used judiciously, as these can act as a potential nidus for infection. A monofilament nonabsorbable suture is preferable for skin reapproximation. The facial tissues have an abundant arterial supply; thus, minimal excision and debridement of tissue should be performed. If tissue is severely damaged and likely necrotic because of a crush injury or loss of vascularity, this should be removed, as it can act as a nidus for infection. An alternative strategy is minimal debridement and monitoring the wound with packing and repeated washouts and debridements until the treating provider is satisfied all necrotic material is removed before proceeding with closure/reconstruction of the wounds. Unfortunately, this management strategy is likely to have increased scarring, which ultimately is cosmetically detrimental.

Avulsive wounds with tissue loss require consideration for closure by secondary intention, local tissue rearrangement, skin grafting, or free tissue transfer depending on the size and the location of the defect. Cosmetically and functionally sensitive areas, such as the perioral tissues and periorbital tissues, require careful evaluation. Local rearrangement of tissue with advancement of mucosa and the skin of the lip may be sufficient to allow a cosmetic and functional result if orbicularis oris is intact (**Fig. 1**). With some avulsive lip injuries, consideration can be given to reimplanting the avulsed tissue if the patient is seen quickly following the injury (**Fig. 2**). This strategy is risky, and complete loss of the replaced avulsed tissue can occur frequently. Generally, if orbicularis oris is not intact, wedge resection with primary closure across the defect versus an Abbe or an Estlander flap may need to be considered (**Fig. 3**). Larger defects may require reconstruction with advancement flaps, like Fernandes, Bernard, or Karapandzic flaps. Complete loss of the lip will require free tissue transfer. With regards to the periorbital tissues, assessment of lacrimal system should be performed. Any defects in the lacrimal system require dacryocystorhinostomy. Reconstruction to allow functional return of the sphincter

Fig. 1. Beagle dog bite to upper lip with loss of tissue. (*A*) Patient seen in the emergency department with dog bite to upper lip with loss of tissue. (*B*) Intraoperatively after washout and debridement with local tissue rearrangement. (*C*) Three weeks postoperatively with acceptable cosmesis.

Fig. 2. Doberman dog bite with complete avulsion of the right upper lip. (*A*) Wound as seen in the emergency department approximately 2 hours after the injury. (*B*) Tissue reflected to show extent of tissue loss. Patient brought avulsed tissue. (*C*) Following washout and debridement with replacement of avulsed tissue right upper lip. (*D*) Three weeks postrepair. Vermillion survived. Some secondary healing in area of skin but relatively fair cosmetic result given extent of the injury.

mechanism of the periorbital and perioral tissues is of prime importance. Without return of the sphincter function, long-lasting and severe functional and cosmetic impediment will be the result.

Reconstruction of the nasal and ear defects can also be complex. Partial avulsions of the ear can sometimes be reapproximated and reanastomosed without loss if a vascular pedicle is maintained. If this is performed, a bolster dressing needs to be placed. If partial avulsion occurs without maintenance of a vascular pedicle, either the pocket reconstruction method (Fig. 4) (Mladick

Fig. 3. (*A*) A 23-year-old woman with multiple facial lacerations and an avulsive injury involving the lower lip as a result of a dog bite by a pit bull. (*B*) After closure of lacerations primarily. (*C*, *D*) Delayed closure at 6 weeks with an Estlander flap. (*E*) One week postrepair. (*F*) Six weeks postrepair.

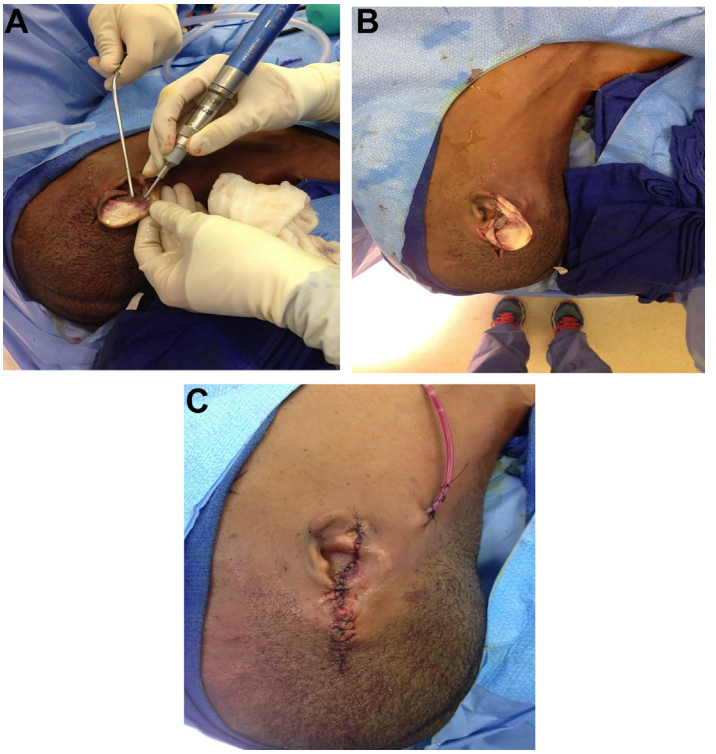

Fig. 4. Patient sustained a bite to his right ear during an altercation resulting in partial avulsion. (*A*) The avulsed portion sutured back primarily. (*B*) The avulsed portion deepithelialized with a diamond bur and (*C*) buried in a retroauricular pocket.

technique) or cartilage grafting with a temporoparietal fascia flap and skin flap can be used.[12] Complete avulsions of the ear may need either prosthetic replacement with an implant-retained prosthesis or complete reconstruction with rib cartilage grafting along with scalp skin flaps and temporoparietal fascia flap. With regards to the nose, soft tissue defects with maintenance of the underlying cartilage can be managed with either local tissue rearrangement or full-thickness skin grafting (Fig. 5). If a defect of the nasal cartilage occurs, cartilage grafting with pedicle flap or free tissue transfer may be required. Complete loss of nose may be managed with an implant-retained prosthesis by an anaplastologist. An osteocutaneous radial forearm free flap is also frequently used in total nasal defects.

With regards to animal bites affecting the area of the parotid gland, the treating provider needs to consider facial nerve damage and parotid duct

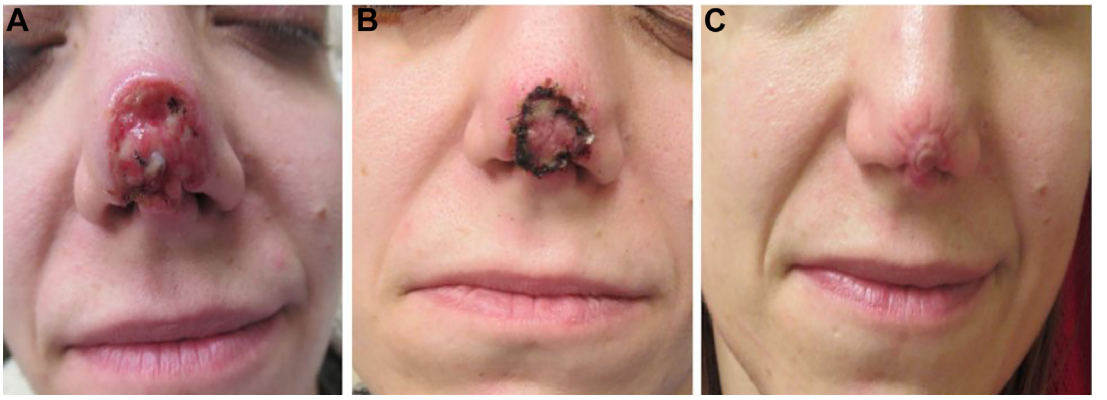

Fig. 5. Human bite to the nose with Lackmann IIIB injury. (*A*) One week after the injury with granulation in wound bed. (*B*) Two weeks after the injury with supraclavicular full-thickness graft 5 days in place. (*C*) Four weeks after the injury with full-thickness skin graft integrating well.

injuries. Injuries to the cheek on a line connecting the tragus of the ear to the upper lip where the philtrum meets the vermillion as defined by Van Sickels[13] should be viewed with suspicion for a parotid duct injury. To evaluate the parotid duct, a catheter can be inserted through Stensen duct intraorally and irrigated in a retrograde fashion. If irrigant is noted to be coming from the wound, then a parotid duct injury is present; this can be confirmed with sialography. Injury in the middle or distal portion of the parotid duct can be repaired. Injury of the parotid duct in the proximal third or within the gland is difficult to repair. Management of this type of parotid duct injury is best with Botox to the parotid gland, or pressure dressing with antisialagogues can be considered. If a sialocele develops, this can be managed with aspiration and sialagogues (**Fig. 6**). Injuries to the parotid duct signal possible injury to the buccal branch of the facial nerve because of their intimate relationship. If a facial nerve injury is suspected, the location of the facial nerve injury should be evaluated. Facial nerve injuries located distally along the branch are generally not repaired. As a rule of thumb, injuries to facial nerve branches at a point distal to a vertical dropped from the lateral canthus of the eye are not repaired. More proximal injuries on the facial nerve should ideally be explored within 72 hours of injury and repaired if possible. When repairing facial nerve injuries, no tension should be put on the repaired nerve, as this will increase the risk of failure. If any tension is present at reapproximation of the nerve, a nerve graft should be used. This scenario is often the case in traumatic injuries because of the edema of the surrounding tissues, which results in retraction of the severed nerve ends.

Animal bite injuries, and in particular dog bite injuries to the scalp, especially in pediatric patients, can result in significant hemorrhage. Hemorrhage control as part of the ATLS should already have been performed. When repairing an extensive scalp wound defect secondary to animal bites, consideration should be given to active draining suction placement. Active draining suction placement decreases the risk of this hematoma formation and subsequent infection with effective healing. Severe facial injuries with massive facial tissue loss can rarely occur following animal bites. The world's first successful face transplant was performed in 2005 in France on a 38-year-old female patient who sustained a facial dog bite with massive tissue loss.[14] The patient lost her lips, nose, and right periorbital tissues as a result of her injury. She underwent an allograft in 2005 in Amiens, France. The patient initially did well but, unfortunately, suffered from chronic rejection of the allograft and succumbed to malignancy because of her immunocompromised state and died in 2016. This case exemplifies not only that animal bite wounds to the face can be extremely disfiguring but also that patients are willing to undertake extreme and sometimes experimental therapies as part of their treatment.

Fig. 6. Aspiration of sialocele 2 weeks following a dog bite to the right cheek with injury to intraglandular component of parotid duct.

Medical Management

Given the polymicrobial nature of animal bite wounds, antibiotic prophylaxis is strongly recommended. On the face, in the context of primary closure of the wound, the requirement for antibiotic prophylaxis is of the utmost importance in minimizing infection and subsequent sequelae of increased scarring and cosmetic impediment. Based on the previously discussed microbiology, amoxicillin/clavulanate is the antibiotic of choice. Amoxicillin/clavulanate has a good broad spectrum of activity and is active against most bacteria that are thought to be involved in dog, cat, and human bites. In a patient with allergy to penicillin, there is divergence of opinion with regards to the best alternative. Clindamycin is generally favored; however, in the authors' experience, clindamycin in isolation as a prophylactic antibiotic tends to have a relatively high risk of infection at the bite wound. If clindamycin is chosen, it should ideally be supplemented with either fluoroquinolone or trimethoprim sulfamethoxazole. Doxycycline is another alternative; however, its bacteriostatic effect it makes it less favorable than penicillin-based antibiotics. Moxifloxacin has good activity against most animal bite wound microbes with the exception of *Fusobacterium*. Its cost can sometimes be prohibitive. A macrolide like azithromycin is the least preferred empiric antibiotic to use in the treatment of animal bites. If a wound infection occurs, cultures should be obtained and

submitted to microbiology to aid directed antimicrobial therapy. Consideration should be given to opening of the sutures and irrigating and debriding the wound.

The tetanus status of the patient should be ascertained. If the patient has not received a tetanus vaccine in 10 years, tetanus immunoglobulin with a tetanus vaccine should be administered. If a tetanus vaccine has not been delivered within 5 years, a tetanus vaccine should be administered and consideration given to tetanus immunoglobulin depending on the injury. As previously discussed, consideration should be also given to the possibility of rabies and the need for rabies postexposure prophylaxis. A special consideration for human bite wounds is the possibility of HIV, hepatitis B, and hepatitis C infection. Baseline blood tests should be drawn. Questions should be asked regarding the patient's history and exposure to HIV, hepatitis B, and hepatitis C, and this needs to be documented. Consideration should be given to postexposure prophylaxis for HIV. With regards to this, infectious disease expert should be involved.

Animal bites to the face in general tend to be very distressing psychological injuries. Consideration of the patient's coping mechanisms should be included in the evaluation and consideration for referral to psychiatry, which are particularly important with severe and disfiguring injuries.

SUMMARY

Animal bite wounds to the face can result in severe injuries that can have long-lasting consequences. Thankfully, most animal bite wounds to the face can be managed in an outpatient setting with close monitoring. Infection is always a risk but with modern understanding of the microbiology involved, relatively good empiric antibiotic therapy can be administered to reduce the risk of the consequences of infection. As most animal bite wounds to the face are caused by dogs, and most dog bite wounds of the face are in children, prevention should be a primary focus. Prevention can avoid not only the physical stress of the injury but also the inevitable psychological injury involved.

CLINICS CARE POINTS

- Dog and cat bites have a high incidence of Pasteurella infection.
- All animal bite wounds should be washed out.
- A penicillin-based antibiotic is preferable.
- Every attempt should be made to close facial bite wounds even with delayed presentation.

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