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Original Article

Surgical treatment of mammalian bites—experience in the management of facial wounds by dog and cat bite in China

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Abstract: Mammalian bites to the face challenges not only related to wound healing but also to aesthetic outcomes. This study aims to summarize 7 years of experience in treating mammalian bite wounds and propose a surgical approach for managing these wounds. From July 2016 to August 2023, 185 cases were treated and retrospectively evaluated. Variables collected included age, gender, anatomical location, wound features, and treatment management. The postoperative results were reviewed and analyzed. Of the 185 patients, 27.57% were under 18 years of age; with dog bites accounting for approximately 89.19% of cases. Notably, 59.46% of the injuries occurred in females. The most common injury sites were the forehead, chin, and cheek. Primary closure was utilized for 96.22% of the wounds. The fatty areas, such as the cheek, parotid gland, and mandibular region, were identified as high-risk areas for bite infections. In contrast, the forehead, periocular, nose, ear, and lip were classified as low-risk areas, while other regions were considered moderate-risk zones. The infection rates post-primary closure for high, moderate and low-risk areas are 9.09%, 6.67%, and 2.56%, respectively. Complex mammalian bite wounds should receive prompt plastic and reconstructive surgical treatment at a tertiary center. Most wounds can be effectively repaired with primary closure and other plastic techniques. Special attention should be given to high-risk bite wounds to prevent infection. This paper provides essential considerations and recommendations for the medical and surgical management of patients presenting with bite injuries.

Keywords: Animal bites, acute wounds, mammalian bites, facial injuries

Introduction

China has the largest population of dogs and cats in the world. It has been reported that the number of domestic dogs and cats in China reached 150 million in 2013, with an annual increase of approximately 10% [1]. Animal bites and bite-associated diseases are considered to be significant public and economic problems all over the world [2]. According to epidemiological data from the Ministry of Public Health of China, more than 40 million cases of animal bite injuries were reported annually in 2009 [1, 3].

At our hospital, animal bites account for 20% of total emergency department visits, with dog bites representing approximately 85% to 90% and cat bites accounting for 10% to 15%. Compared with other traumatic injuries, various pathogenic bacteria can be isolated from mammalian bite wounds [4], posing a higher risk of bacterial and fungal infections [2, 5]. In addition, mammalian bites can cause serious diseases such as rabies and tetanus [6, 7]. Statistics show that 97%, 2%, 1% of human rabies cases are transmitted by bites or scratches from infected dogs, cats, and other mammals [8]. The blunt teeth and strong jaws of dogs can cause lacerations, leading to severe and complex soft tissue injuries. In contrast, cats possess sharp, long, thin teeth that can penetrate deep into tissue, bones, and joints. Therefore, the severity of bite wounds varies from superfi-

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Table 1. Characteristics of patients

Total	Contents	Data (percent)
Age	0-18 (y)	51 (27.57%)
	19-50 (y)	93 (50.27%)
	51-82 (y)	41 (22.16%)
Gender	Male	75 (40.54%)
	Female	110 (59.46%)
Comorbidity	Hypertension	12 (6.49%)
	Diabetes	8 (4.32%)
	Immune Deficiency	0 (0%)
The animal that caused the bite	Dog	165 (89.19%)
	Cat	20 (10.81%)
Timing of medical evaluation after the initial injury	0.5-1 (h)	97 (52.43%)
	1-3 (h)	59 (31.89%)
	3-10 (h)	29 (15.68%)
Follow up	Mean ± SD	3.57 ± 6.98 months
	Range	1 month-7 years

cial abrasions and lacerations to severe injuries resulting in tissue necrosis and detachment. Patients often require additional treatment due to high bacterial infection rates, complications, and aesthetic and functional sequelae.

Most literature concerning the treatment of mammalian bite patients focuses on the incidence of postoperative infection. However, statistical analyses of infection rates related to specific bite sites are limited. Moreover, facial appearance and scar repair are crucial evaluation criteria for treating facial bite patients. The Emergency Department of our hospital and the Department of Plastic Surgery collaborate to perform plastic surgery on facial animal bite wounds, aiming to help patients repair their injuries and minimize scarring. We present our treatment experiences in this paper.

Patients

A retrospective study of facial mammalian bite cases was conducted from July 2016 to August 2023, including a total of 185 cases. These patients were referred for plastic surgical consultation by the Emergency Department (ED). The study was approved by the hospital's institutional review board (IRB approval number: 20231009-k174).

The selected cases met the following criteria: 1) Animal bites on the face, without severe lacerations elsewhere; 2) Wounds deeper than the dermis and required surgical intervention. The exclusion criteria included: 1) Incomplete patient information; 2) General contraindications for anesthesia or surgery; 3) Shallow wound that did not require surgery treatment; 4) Bites in immunocompromised patients; 5) Failure to follow up as scheduled.

Methods

Initial evaluation

For patients with animal bites, detailed information was recorded, including age and gender of the patient, the animal involved, wound location, the time elapsed since the bite, and preventive measures for tetanus and rabies. Additionally, the presence of conditions such as diabetes or hypertension was noted. Patient characteristics are summarized in **Table 1**.

The need for rabies prophylaxis should be addressed with any mammalian bite, as domestic animals may often be unvaccinated or inadequately vaccinated. For patients classified as having tertiary exposure, post-exposure rabies prophylaxis should include the administration of immune globulin at presentation, along with vaccinations on days 0, 3, 7, 14, and 28. If the animal is a high-risk vector for rabies, the rabies immunoglobulin (20 IU/kg) was injected around the borders of the wound and distal to the bite site intramuscularly. A three-dose booster could be given on days 0, 3, 7 if the

patient has received the full dose of rabies vaccine within the past 3 years, while a two-dose booster could be given on days 0 and 3 if the complete series was administered within the past year. Rabies immunoglobulin is not required if the patient has been fully immunized within the last 10 years [9]. Given the high likelihood of tetanus development from animal bites, a tetanus vaccination should be given if the person has not received it in the previous 5 years [10, 11].

As the rabies virus is easily inactivated at PH>8, a pulsed wash with a 1% alkaline solution for about 15 minutes post-injury can decompose the glycoprotein and lipoprotein of the virus [12], rendering it non-infectious and facilitating its removal. The amount of irrigant used is contingent upon the wound size and contamination level, typically ranging from 250 to 500 ml. The wound was then actively cleaned with a 1:10000 iodine-containing preparation solution to minimize bacterial colonization and prevent infection [13]. This immunization and initial irrigation process is usually completed in the emergency department; severe animal bites are referred for plastic surgery.

Treatment strategy

A thorough examine towards the wound's location, depth, and extent, including assessments for fractures, tissue loss, and nerve damage, is essential. After evaluation, the need for sutures is determined. In cases of severe contamination, repair may be postponed. In cases of tissue-penetrating wounds with small external openings and deep subcutaneous cavities, the subcutaneous cavity should be enlarged and thoroughly drained. If skin loss exceeds the limits of direct closure, skin grafting or flap transfer may be required, delaying wound repair accordingly. If necessary, Vacuum Closed Drainage (VSD) negative pressure drainage could be used. It usually takes 7-14 days before the wound reaches a reparable condition (fresh granulation tissue, without purulent material). For other facial injuries, including lacerations extending into muscular or periosteal layers, primary closure can be performed if there is no significant tissue loss.

The procedure included local or general anesthesia, new extensive irrigation with hydrogen peroxide, povidone-iodine solution, and 0.9% normal saline, with thorough and profound debridement, removal of obvious necrotic tissue, and wound edge excision. The superficial tissue of the bite wound is typically excised in areas with non-essential vessels and nerves to reduce infection risk. Single-strand absorbable sutures should be used for deep cavity suture, avoiding braided suture. Sutures are made by first aligning obvious organ landmarks, such as the lip arch, eyebrows, hairline, and nasal flanges. Care should be taken to avoid leaving cavities in deep tissue, and intensive subcutaneous suturing should be avoided. A drainage strip should be placed in the incision after suturing.

Postoperative management

A daily assessment is performed to determine if the wound is infected. Criteria for diagnosing wound infection involved assessing local symptoms such as purulent wound discharge, erythema, pain, and swelling, as well as systemic symptoms such as fever (temperature >38°C), leukocytosis of more than 12×10^9/L, elevated C-reactive protein, and bacteremia [14]. In addition, wound bacterial culture can also aid in diagnosing infection.

The drainage strip is typically removed 48 hours after operation. In the absence of widespread infection, sutures on the head and face were generally removed 7 days after surgery. Suppuration generally occurs about 2-3 days post-injury. If suppuration arises, the sutures around the suppuration or at the low drainage could be removed, and the suppurate area was washed with hydrogen peroxide and iodophor alternately twice a day. Mupirocin cream was applied topically and the wound was stuffed with a small gauze.

Prompt antibiotic therapy, either oral or intravenous, is essential based on wound severity and local antimicrobial guidelines. Oral antibiotics, such as compound beta-lactam or quinolone antibiotics with enzyme inhibitors, are recommended for 3 to 5 days [9]. When antibiotics are given intravenously, they are often combined with metronidazole.

Measurements

Measurements included infection rates, scarring, and patient/parent satisfaction with re-

sults. Infection rate = [cases of infection/cases] × 100%. Scarring and patient/parent satisfaction were evaluated using the Scar Cosmesis Assessment and Rating (SCAR) scale (**Table 2**) on the 30th-day post-surgery [15]. Scores (0-15) represent the best possible scar to the worst possible scar. The score of 0-3 was very satisfied, 4-7 was satisfied, 8-11 was not satisfied, and 12-15 was very bad; patients who were very satisfied and satisfied were counted in the patient satisfaction rate.

Statistical analyses were performed using percentages, with patient characteristics compared using the χ^2 test to characterize the study population. All statistical analyses were performed using SPSS Statistics 25.0, and $P<0.05$ was considered statistically significant.

Result

Characteristics of wound

Of the 185 patients included in the study, 4 (2.16%) exhibited tissue loss, and 3 (1.62%) bites were heavily contaminated, leading to deferred wound repair. In 178 cases, debridement and primary closure were carried out (96.22%). A total of 10 patients developed wound infections (5.62%). The primary locations of the wounds were the forehead (n = 28; 15.14%), followed by the mandibular region (n = 23; 12.43%), cheek (n = 22; 11.89%), and chin (n = 21; 11.35%) (**Table 3**).

Infection rate

The most common sites of postoperative infection were the parotid gland region (9.09%), cheek (9.52%), and mandibular (8.70%). In contrast, infections in the periorbital, lip, nose, and forehead regions were rare, with an average infection rate of 2.56% (**Figure 1**). There were no significant differences in the incidence of postoperative infections between dog bites and cat bites (5.03% versus 10.53%, P = 0.648).

Among the 10 patients with wound infection, the infection area was localized and presented without systemic symptoms. Treatment involved the removal of local sutures, thorough drainage of the wound, and daily dressing changes with iodophor gauze. The treatment duration for wound infections typically ranges from 3 to 4 weeks.

Scar

In the cases of primary closure, areas without infection display mild scarring and a favorable appearance, while scars at the infective sites were relatively obvious compared with the rest of the wound (**Figure 4**). However, in general, the overall appearance of the wound was superior to that of the secondary suture. The average score of SCAR was (1.35 ± 0.53) in primary suture cases and (4.43 ± 0.79) in secondary suture cases.

Patient/parent satisfaction

The satisfaction rate in primary suture cases was 95%. In cases requiring secondary repair, the scars from flap transplantation were generally inconspicuous, resulting in a satisfactory rate of 85.71%. One case exhibited a conspicuous scar from a transplanted free skin graft due to its contracture.

Cases

Figure 2 depicts a dog bite injury on the face of a 2-year-old child with immediate wound repair and primary suture. Scars are inconspicuous 8 months after repair. **Figure 3** illustrates an 18-month-old child attacked by a dog on the lower lip with wound primary closure. Seven years after wound repairment, the child received a favorable appearance. **Figure 4** depicts a dog bite injury on the nasolabial fold and cheek of a 22-year-old female patient with immediate wound repair and primary suture. Seven days after wound primary closure, the lateral part of the oral commissure (black dotted frame) was infected. Four years after repair areas without infection display mild scarring and a favorable appearance, while scars at the infective sites were relatively obvious compared with the rest of the wound. **Figure 5** shows a dog bite injury on the ear of a 38-year-old female patient. Scars are inconspicuous 1 month after repair. **Figure 6** illustrates a cat-bite injury on the lower eyelid of a 20-year-old female patient. Scars are mild 1 month after the wound's primary closure.

Discussion

Mammalian bites can occur in various anatomical locations, with approximately 17% affecting the head and neck [16]. The facial area, being the most exposed part of the human body, is

Table 2. The Scar Cosmesis Assessment and Rating (SCAR) scale

Variables	Contents	Scores
Clinician questions		
Scar spread	None/near invisible	0
	Pencil-thin line	1
	Mild spread, noticeable on close inspection	2
	Moderate spread, obvious scarring	3
	Severe spread	4
Erythema	None	0
	Light pink, some telangiectasias may be present	1
	Red, many telangiectasias may be present	2
	Deep red or purple	3
Dyspigmentation (includes hyperpigmentation and hypopigmentation)	Absent	0
	Present	1
Track marks or suture marks	Absent	0
	Present	1
Hypertrophy/atrophy	None	0
	Mild: palpable, barely visible hypertrophy or atrophy	1
	Moderate: clearly visible hypertrophy or atrophy	2
	Severe: marked hypertrophy or atrophy or keloid formation	3
Overall impression	Desirable scar	0
	Undesirable scar	1
Patient questions		
Have you been bothered by any itch from the scar in the past 24 h?	No	0
	Yes	1
Have you been bothered by any pain from the scar in the past 24 h?	No	0
	Yes	1
Total scores	Best possible scar to worst possible scar	0-15

Table 3. Wound location

Wound location	Cases (n = 185)	Cases of infection (with primary suture, n = 178)	Average infection rate (n = 178)
High-risk		55	
Mandibular	23	2/23 (8.70%)	
Cheek	22	2/21 (9.52%)	9.09
Parotid gland	11	1/11 (9.09%)	
Low-risk		78	
Forehead	28	1/27 (3.70%)	
Chin	21	1/21 (4.76%)	
Nose	8	0/7 (0%)	2.56
Periorbital	9	0/8 (0%)	
Lip	10	0/9 (0%)	
Ear	7	0/6 (0%)	
Medium-risk		45	
Perioral	15	1/15 (6.67%)	
Temporal	15	1/14 (7.14%)	6.67
Neck	16	1/16 (6.67%)	

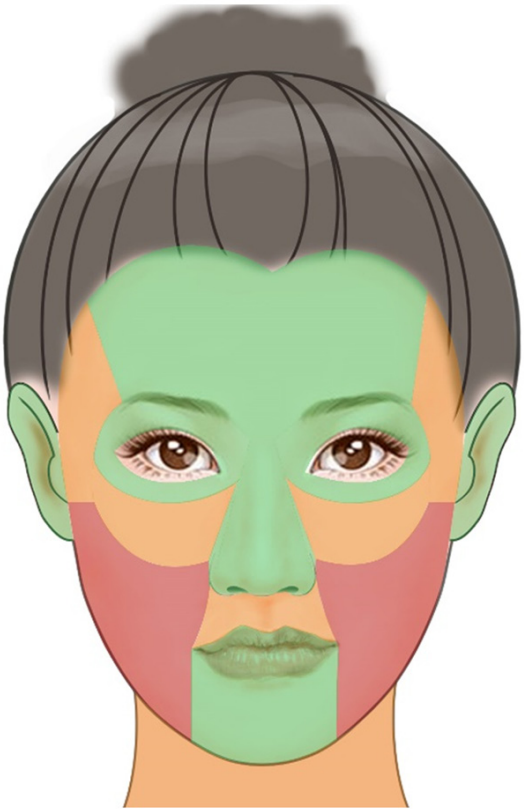

Figure 1. Schematic diagram of the infection risk in different facial bite areas. Red, Orange, and Green zones represent high, medium, and low-risk infection areas.

critical for aesthetic considerations; thus, the initial treatment after injury is paramount. Inadequate management can result in permanent defects, which require multiple plastic repairs in the later stage, bringing serious economic and psychological burdens.

The primary pathogen involved in bite wounds is typically the normal oral flora of the biting animal. Pasteurella species (spp.) are the most commonly isolated organisms in both cat and dog bites, while staphylococcus and streptococcus are present in about 40% of such cases [14]. Extensive tissue damage caused by full-thickness wounds, particularly from tearing injury, has been shown to predispose colonization of bacteria and increase the likelihood of infection compared to partial-thickness wounds [17]. Therefore, all bite wounds should be carefully examined and evaluated before treatment to avoid overlooking serious combined injuries.

Patients with comorbidities such as diabetes, alcoholism, liver disease, and spleen insufficiency, are at a heightened risk for infection. Based on the infection characteristics of bitten animals, large-volume irrigation of bite wounds with 0.9% sodium chloride is an important initial step in preventing infection. Rinsing could remove most of the bacteria and reduce bacterial colony colonization.

Traditionally, it has been recommended to keep these wounds exposed to decrease the risk of rabies transmission and the likelihood of anaerobic infection [18]. However, numerous studies have shown comparable infection rates between closed animal bite wounds, particularly facial wounds, and wounds left open to heal, with the former often resulting in enhanced cosmetic outcomes [19].

In this study, we classified different facial bite areas into three risk zones - high, moderate, and low-based on post-suturing infection rates. The forehead, nose, lip, ear, and other areas are less infected, which are classified as low-risk infection areas. These sites have high muscle content, rich blood supply, strong anti-infection ability, low proportion of adipose tissue,

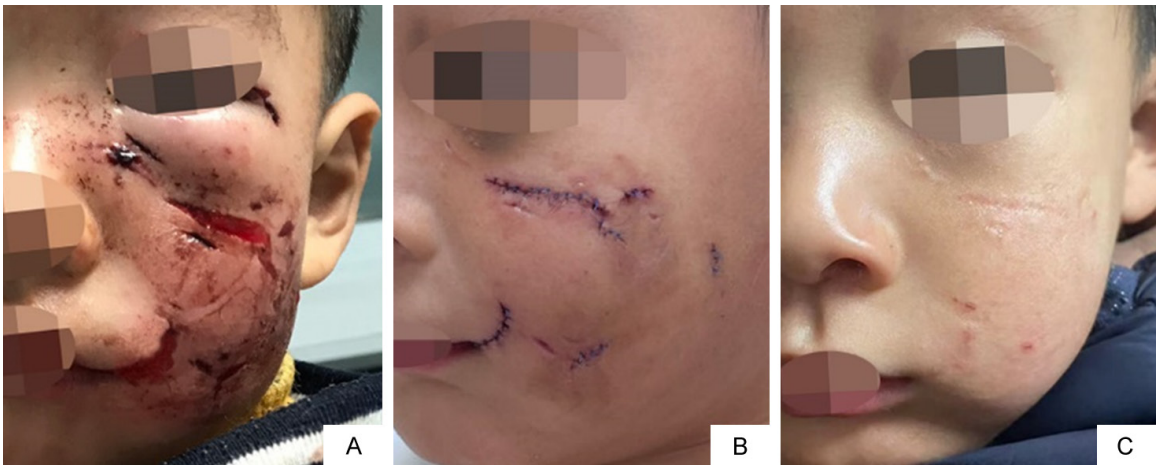

Figure 2. A. Dog-bites injury on the face of a 2-year-old child. B. Immediate repair and primary suture were performed. C. 8 months after repair.

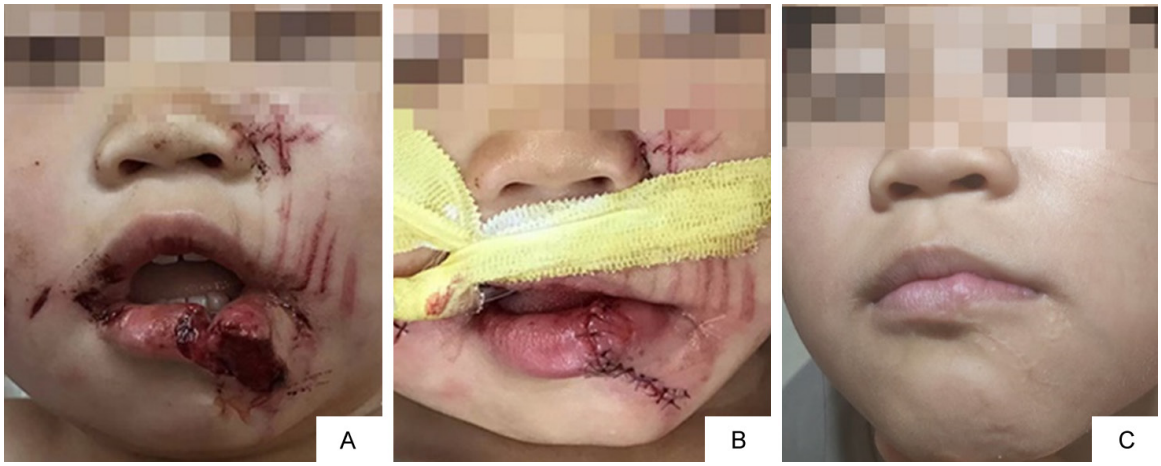

Figure 3. A. Dog-bites injury on the lower lip of an 18-month-old child. B. Immediate repair and primary suture were performed. C. 7 years after wound repairment.

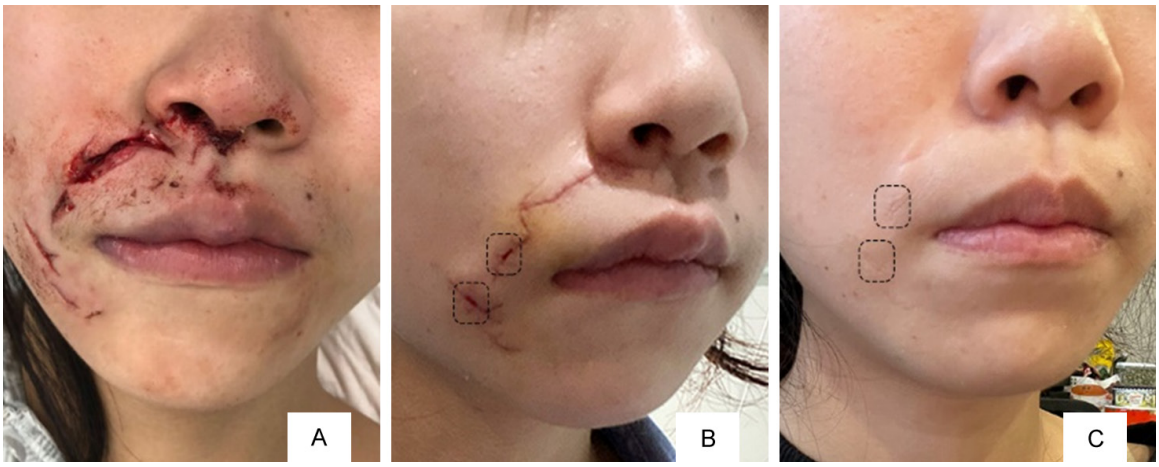

Figure 4. A. Dog-bites injury on the nasolabial fold and cheek of a 22-year-old female patient. B. 7 days after wound primary closure, with infection areas at the lateral part of the oral commissure (black dotted frame). C. 4 years after repair.

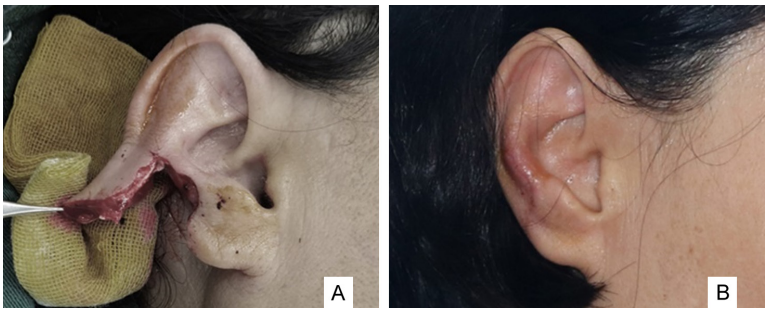

Figure 5. A. Dog-bites injury on the ear of a 38-year-old female patient. B. 1 month after wound primary closure.

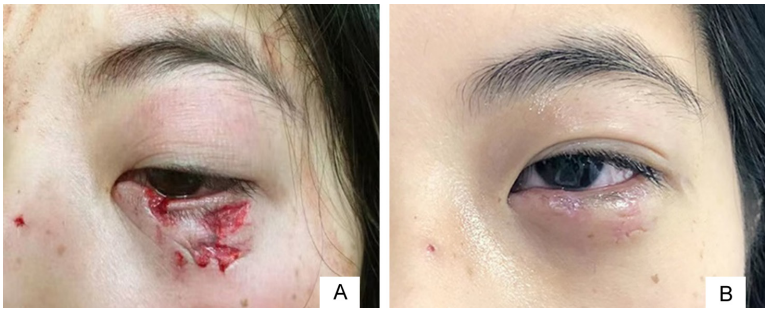

Figure 6. A. Cat-bites injury on the lower eyelid of a 20-year-old female patient. B. 1 month after wound primary closure.

and relatively dense tissue, making them less susceptible to the spread of infection. The periorbital region, although delicate and soft, is protected by the brow bone and zygomatic bones, which generally prevents damage to the orbital septum fat pad deep to the orbicularis oculi muscle, further categorizing it as low-risk for infection. Conversely, the cheek, nasolabial fold, parotid gland region, and mandibular region were identified as the most common infection areas, characterized by fatty tissue prone to fat liquefaction and loose structure that facilitates the spread of infection within cavities. These regions were classified as high-risk infection areas. The other parts were classified as moderate-risk zones, and the risk of infection was related to the area and depth of injury. For wounds in high-risk areas, part of adipose tissue and a thin layer of wound inner wall tissue should be properly removed during debridement, accompanied by using antibiotic prophylaxis.

However, post-exposure antibiotic prophylaxis for most bites remains controversial. Studies have shown that antimicrobials are not required prophylactically in dog bite wounds, except in high-risk cases [20]. As mentioned in a 2014 review, the only evidence-based benefit of prophylactic antibiotics pertains to hand bites [21]. Other scholars have argued that antibiotic prophylaxis should be considered for all bites requiring closure and for high-risk bites [22]. A study investigating dog bites in children at an Italian hospital reported favorable cosmetic outcomes and very low infection rates when prophylactic antibiotics were administered concurrently with initial closure [23]. Our clinical experience suggests that antibiotics are not routinely used for superficial wounds, but prophylactic antibiotics are warranted in areas deemed at high risk for infection.

In this study, infection sites were typically confined to poorly draining areas and were manageable through daily dressing changes. The duration of treatment depends on the type of infection, with one week of treatment being sufficient for simple skin infections, while more severe cases require 3 to 4 weeks of management.

A limitation of the study is that, as a retrospective report, lack of systematic randomization in the selection of a sample. Regarding surgical treatment, it is unlikely to complete a standardization of surgical techniques. Finally, the study's small sample size is also limiting.

Conclusion

In this retrospective analysis of animal bite wounds, we concluded that active wound cleaning and debridement are key factors in treatment. The primary closure of facial wounds, with appropriate evaluation and treatment, could yield superior aesthetic results.

Disclosure of conflict of interest

None.

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