Dog-Bite–Related Craniofacial Fractures among Pediatric Patients: A Case Series and Review of Literature

Robert Saadi, MD[1] Benjamin S. Oberman, MD[2] Jessyka G. Lighthall, MD[1]

[1] Division of Otolaryngology - Head and Neck Surgery, Department of Surgery, The Pennsylvania State University, Hershey, Pennsylvania
[2] North Carolina Eye, Ear, Nose, and Throat, Durham, North Carolina

Address for correspondence Jessyka Lighthall, MD, Department of Surgery, The Pennsylvania State University, College of Medicine, 500 University Drive, H091, Hershey, PA 17033-0850 (e-mail: jlighthall@pennstatehealth.psu.edu).

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Abstract

Dog bites in the pediatric population commonly cause injuries to the head and can be associated with fractures, often leading to prolonged hospital stays, multiple surgical interventions, and long-term complications. Our goal was to evaluate our experience with dog-bite–related craniofacial fractures, understand frequency and demographics of these fractures, identify common fracture patterns, and provide recommendations based on management and complications encountered. The institution's electronic medical record was reviewed. A review of the English literature for the past 20 years was also conducted. A retrospective chart review was conducted using ICD-9 codes to include all patients with head and neck dog bites and craniofacial fractures. Fractures resulting from canine bites to the face and scalp were rare, occurring in our study in less than 1% of total facial dog bites (1,069 cases) and 1.5% of pediatric facial dog bites (462 cases). Ages ranged from 5 months to 9 years at the time of presentation. A total of seven patients, all pediatric, were documented. All seven patients required operative intervention for their wounds, and five patients required at least two operative interventions. Midface and skull fractures were the most commonly encountered fracture sites. Dog bite injuries to the face in young children, especially when severe, should raise suspicion for fracture of underlying bone. Management of these injuries should include a multidisciplinary approach and focus on repair of soft tissue and skeletal deformities. Furthermore, it is prudent to follow up patients who require operative management after injury to monitor for long-term complications, given the significant proportion of complications and operative takebacks in this study.

Keywords
- dog bite
- fracture
- facial
- craniofacial
- severe
- pediatric

An estimated 800,000 of 4.7 million dog bites per year require medical attention, constituting 12.9 per every 10,000 visits to U.S. emergency departments.[1,2] In children younger than 7 years, these injuries represent a significant proportion of all maxillofacial traumas, nearing 30%.[3,4] Due to a young child's short stature, proportionally large head, and lack of defensive strength, the incidence of facial dog bites varies inversely with age.[5] As much as 80% of pediatric dog bite injuries, an estimated 44,000 cases per year, occur on the head and neck.[2,4–7] Furthermore, in the vast majority of cases in the United States, the attacking dog is owned by the victim's family or friends.[8,9]

The mechanism of injury in a dog bite attack is unique, which yields important considerations in initial survey, surgical reconstruction, and prophylaxis. Soft-tissue injuries from a bite are generally classified into three major types: laceration, avulsion, and puncture.[10] A bite attack characteristically involves forceful, penetrating injuries with following shear action

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that together can result in major avulsions of skin, de-vitalization of soft tissue, and damage to the underlying neurovascular structures.[11,12] Although cat and human bites are much more likely to become infected, dog bites still carry around a 10% risk of infection. *Pasteurella multocida* is the most commonly cultured organism in the first 24 hours, and accounts for 25% of all infections from dog bites. Of note, consideration for rabies postexposure prophylaxis is more urgent with bites of the head and neck, given the proximity to the brain.[13] The face and scalp have rich vasculature with good blood flow to prevent infection; however, the crush and puncture actions associated with dog bites can cause tissue ischemia and deep lacerations, creating a nidus for infection.[14,15] Dog-bite–related fatalities are infrequent, occurring in roughly 20 cases per year in the United States, and most often result from massive hemorrhage in cases of carotid trauma.[11,12,16,17] Serious injuries requiring major reconstruction often involve the nose, lips, and ears.[18] The nose, lips, and cheeks have been deemed the "central target area," as these structures are most commonly affected by facial dog bites.[18,19]

Although somewhat rare, the compressive force of dog bites can be sufficient to fracture bones, especially the thin facial bones of a child. The overall incidence of facial fractures from this injury is unknown, with general and pediatric chart reviews often reporting no such cases.[5,9,20,21] As such, health care personnel are less aware of the potential for this complication. Fractures involving the orbit, nasal bones, and skull have been most commonly reported.[12,22–24] Children who have dog bites severe enough to cause fractures frequently require hospitalization and staged procedures, with some requiring prolonged pediatric intensive care unit stays.[24] It was our goal to evaluate our institution's experience with dog-bite–related craniofacial fractures and review the available literature regarding such injuries. By doing so, we hoped to understand the demographics and patterns of dog-bite–related facial fractures and to discuss circumstances that should raise suspicion for this poorly recognized sequela of injury. It was also our goal to review management and complications in an effort to provide a treatment algorithm for use when these patients are encountered.

Methods

A retrospective chart review approved by the institution's Institutional Review Board was conducted using a database query of the Cerner Electronic Medical Record to identify all potential subjects. Patient visits in the past 5 years (January 1, 2010, to June 1, 2015) were filtered using ICD-9 codes: E906.0 (dog bite), 872.x – 874.9 (all head/neck open wounds), 800.xx – 804.99 (all head fractures). Pediatric patients were defined as all patients younger than 18 years. Only patients with facial injuries as a result of dog bites were included, and these patients were then further filtered to a subgroup of patients with a facial fracture ICD-9 code. Eligibility for the subgroup was determined by review of individual cases by the primary investigator and required a facial fracture as a direct and sole result of a dog bite injury to the face. Patients who sustained a fracture during the attack from a related injury, such as falling to the ground after being bitten, were excluded. Patient demographics, dog breed, soft-tissue injuries, fracture sites, operative interventions, and complications were reviewed. Microsoft Excel Software was used for data analysis.

The current literature on dog-bite–related facial fractures was reviewed. and Ovid searches were performed by title, relevance, and date using key words such as "dog, bite, facial, fracture, and severe" and references from these publications were reviewed for missed publications. Individual pediatric case reports over the past 20 years were reviewed. Articles were excluded from analysis if they did not specify fracture site, demographics, or management.

Results

A total of seven patients, all pediatric, were documented to have associated facial fractures, which constituted 0.7% of all patients and 1.5% of pediatric patients with facial dog bites. Ages of patients ranged from 5 months to 9 years at the time of presentation. All seven patients required operative intervention under general anesthesia for their wounds, and four of the seven patients (57%) required reduction of their facial fractures. Five patients (71%) required at least two operative interventions. All patients received antibiotic prophylaxis and only one patient had a postoperative infection (14%) with *P. multocida*, which developed in association with an undiagnosed skull fracture. The most significant associated injuries requiring further management included intraoral avulsions with dental loss and dural lacerations. In two of the three skull fractures, the diagnoses were not made on initial survey.

More than half of the patients presented with fractures at multiple sites. Midface, orbital, and skull fractures were the most common fracture sites. Fractures in two patients involved significantly comminuted bone. In three cases (43%), prolonged complications requiring additional procedures developed due to intraoral injuries. Interestingly, each case involved a different dog breed, although all were large dogs that were known to the family. Unsupervised patient–canine interaction was an associated factor with the majority of these cases (71%). Only three (43%) of the dogs had any history of aggressive behavior including bite attacks in the past. A summary of these cases can be found in ►**Table 1**.

Literature Review

We compiled seven of the most recent individual case reports from our literature review. Ages ranged between 9 months and 13 years. These cases composed of mainly mandibular fractures and skull fractures. All the mandibular fractures required internal fixation and fracture patterns were somewhat unique, including comminuted fractures of both body and ramus with avulsed condyle, mandibular symphysis fracture, and a vertical mandibular ramus fracture. Associated injuries included eyelid lacerations, facial nerve injury, parotid injury, intraoral avulsions, and dental injury. All skull fractures were at least partially delayed in diagnosis, with one case not being discovered until after abscess development. Patients required hospital stays from 4 days to 2 months following their operative treatment. A complete summary of cases can be found in ►**Table 2**.[25–31]

Table 1 Summary of chart review from institution

Age	Sex	Breed	Associated injury	Fracture	Antibiotic	Imaging	PICU stay	Surgical management	Complications
3 y	F	Italian Mastiff	R Infraorbital, supralabial, and intraoral lacerations and punctures	1. R ZMC 2. R anterior maxillary and alveolar ridge 3. Inferior orbital rim	Clinda	CT on presentation	No	ORIF and dental extraction	1. Exposed hardware requiring removal and debridement 2. Loss of teeth
11 mo	F	Labrador Retriever	1. L auricular laceration/ avulsion 2. Scalp lacerations	1. L depressed skull fractures (7 total open skull punctures) 2. L lateral orbital wall fracture	Amp/Sul changed to Cipro and Metro	Fracture noted in OR, Post-operative CT	Yes	Bifrontal craniotomy for debridement of comminuted bone and dural repair	None
5 mo	F	Rottweiler	Scalp lacerations	R depressed skull fracture	Cephalexin changed to Amp/Sul	CT following development of abscess	No	1. Drainage of abscess 2. Washout and debridement requiring complex wound closure	Abscess (*Pasteurella multocida*)
9 y	F	German Shepherd	Puncture wounds and lacerations over R zygomatic arch and mandible	R mandibular angle	Amp/Sul	CT for trismus	No	ORIF with MMF	Dental pain and nonviable right second molar 2 y later requiring extraction and plate removal
19 mo	M	Pitbull	Bilateral facial lacerations	1. R zygomatic avulsion fracture 2. R mandibular ramus fracture	Amp/Sul	CT on presentation	No	Fractures were nonoperative, irrigation and closure of wounds	None
17 mo	M	Great Dane	1. Avulsed pericranium 2. Lacerated temporalis muscle	R depressed skull fracture	Amp/Sul	CT on presentation	No	Washout and debridement requiring complex wound closure	None
2 y	M	Mix: German Shepherd/ Rottweiler	1. Facial and intraoral lacerations 2. Preseptal hematoma 3. Avulsed right first incisor	1. L orbital floor 2. L hard palate	Amox/Clav	CT on presentation	No	Primary closure of lacerations and interdental wiring	Required a second procedure to fix bony defect in palate

Abbreviations: Amox/Clav, amoxicillin/clavulanate; Amp/Sul, ampicillin/sulbactam; Cipro, ciprofloxacin; Clinda, clindamycin; CT, computed tomography; L, left; Metro, metronidazole; MMF, maxillomandibular fixation; OR, operating room; ORIF, open reduction internal fixation; R, right; ZMC, zygomaticomaxillary complex.

Table 2 Compilation of case reports

Author	Age	Sex	Breed	Associated injuries	Fracture	Abx	Imaging	Repair	Complications
Froind et al[25] (2013)	13 y	F	Pitbull	1. Head, neck, and breast lacerations 2. Neck hematoma	Depressed R skull fracture (transmastoid puncture)	Not specified	CT angio on presentation to rule out vascular injury	Debridement and closure	None, discharged 4 d post-op
Baldi et al[26] (2013)	2 y	F	Rottweiler	Facial lacerations, including a full-thickness upper eyelid laceration	1. Displaced L vertical mandibular ramus fracture 2. L inferior and lateral orbital rim fractures with displaced zygoma	Not specified	CT for Malocclusion with R deviation	ORIF	None, discharged 7 d post-op
de Carvalho et al[27] (2012)	3 y	M	Pitbull	Soft-tissue loss on R including parotid, Stensen's duct, facial nerve, and buccinator muscle	Comminuted fracture of the R mandible of body and ramus with avulsed condyle	Not specified	No imaging performed	Tracheotomy on presentation, ORIF with MMF	Extensive soft-tissue loss, discharged 2 mo post-op
Cottom et al[28] (2011)	5 y	F	–	Facial and intraoral lacerations and luxated left deciduous central incisor	Mandibular symphysis	Not specified	X-ray on presentation	ORIF and dental extraction	None, discharged after 6 wk
Burns et al[29] (2011)	20 mo	F	Bullmastiff	Puncture wounds on neck and scalp and R ear laceration	Depressed R occipital skull fracture	Not specified	Fracture noted in OR, intra-op CT performed	Debridement of bone fragments and repair of dura	None
Walker et al[30] (2009)	9 mo	F	–	Facial lacerations	L mandibular body	Amox/Clav	None, fracture found in OR	ORIF	None
Santana-Montero et al[31] (2009)	2 y	F	Akita	Wounds in occipital area, developed purulence 2 mo after primary closure	Two depressed skull fractures in the occipital area	Ceftriaxone	CT delayed, fracture found after abscess development	L suboccipital craniectomy	Cerebellar abscesses (*Streptococcus intermedius*), discharged 6 wk post-op

Abbreviations: Amox/Clav, amoxicillin/clavulanate; CT, computed tomography; L, left; MMF, maxillomandibular fixation; OR, operating room; ORIF, open reduction internal fixation; R, right.

Discussion

Craniofacial fractures resulting from dog bites are uncommon occurrences that seem to be largely limited to the pediatric population. This observation is in line with the increased frequency of head and neck dog bites in this population and the relatively thin craniofacial bones of young children. The majority of the patients included in this study and in the literature were younger than 7 years. Wei et al published a retrospective chart review of 17 pediatric facial fractures resulting from dog bite attacks presenting over a period of roughly 9 years. They found that 1.4% of pediatric facial dog bites resulted in fractures. Fifty-three percent of the patients were female and the ages ranged from 6 months to 10 years, with an average of 3.9 years.[22] Tu et al reported a case series in which they estimated fractures occurred in less than 5% of cases but did not discuss methods of data collection. They reviewed six patients at their own institution with an age range of 4 to 12 years.[23] Interestingly, we found that the average ages of skull fractures were somewhat lower than other reported fractures, occurring largely in patients younger than 1 year. This agrees with the study of Wei et al showing all skull fractures occurring in children younger than 1 year. Steen et al provided a chart review specifically focused on penetrating skull fractures from canine bites. They reported 10 such incidents with 90% younger than 2 years.[32] Midface (3), orbital (3), and skull fractures (3) were the most common fracture sites in this study. Wei et al found that approximately one-third of the patients had multiple facial fractures with nasal fractures being the most common, followed by skull, zygomatic, and orbital fractures.[22] Tu et al found that half of the patients had multiple fractures and the most common were zygomatic, orbital, and nasal fractures.[23] Craniofacial fractures were also noted in the following general reviews, but typically lacked specification of individual case details. Garvey et al reviewed 282 general pediatric dog bites and showed a 4.6% fracture rate when selecting for only head injuries. The most common were skull (6) and nasal (4) fractures.[24] Gurunluoglu et al documented 75 patients with facial dog bite injuries and found a 6.7% fracture rate, consisting of midface, mandibular, and nasal fractures.[33] Mitchell et al reported a 13.6% fracture rate of children suffering from dog bites to the scalp, face, and neck. The majority were skull fractures, but a midface and a mandibular fractures were also reported.[34] Brogan et al reviewed 40 cases on severe dog bites in children, and found 25% had facial fractures; however, they used exclusion criteria to specifically review severe cases including acute hospitalization or death. The most frequent fractures were skull fractures (8) compared with all other facial fractures (5), with the majority of these patients having multiple fracture sites.[12] Wiseman et al also reviewed cases of serious dog bite injuries (57) and found a 6.7% facial fracture rate when selecting only children with facial injuries.[16]

In general reviews focusing on all dog bites to any part of the body, craniofacial fractures in children are by far the most common fracture type.[12,16,24] Limiting to the pediatric population, based on our study and our literature review, fractures resulting from dog bites to the head are generally reported at a rate of 1 to 6%. Additionally, there does not appear to be significant variations in gender in the current study and aforementioned publications. Severe dog bite injuries to the face may have higher incidence and should always raise suspicion for fracture of underlying bone. Studies focused on severe cases appear to have some of the highest reported fracture rates.[12,16] However, based on our chart review, a lack of severity on initial survey does not appear to preclude the presence of serious fractures. The majority of these patients will require admittance to the hospital. As Mitchell et al noted, fractures may be the strongest factor associated with hospitalization in facial dog bites.[34] Tu et al, Wei et al, and the present study agreed that at least more than 80% of patients required surgery and hospitalization.[22]

The power of a dog bite is generally proportional to the size of the dog's jaw and jaw muscles. The most common dog breeds implicated with facial fractures after an attack are breeds with large jaws, such as the Pitbull, German shepherd, Rottweiler, and Labrador.[22,23,25–27,32] Pitbulls have particularly wide jaws and a behavioral tendency to deliver sustained, prolonged force during a bite. Many bites with associated fractures display a pattern of lacerations on both sides of the bone or lacerations on the opposite side of the head in the cases reviewed. All patients reviewed by Steen et al had scalp lacerations, most commonly present both ipsilateral to the side of the fracture and contralateral.[32] This counterforce most likely helps provide the fixed and sustained pressure required to fracture bone.[8,22,23,32]

The discovery of a fracture in these cases should prompt examination for other fracture sites given that a significant proportion (33–60%) of these patients present with multiple facial fractures.[22,23,32] Despite the fact that facial bites tend to occur more often near the nose, lips, and cheeks, we found that skull fractures seem disproportionately high and perhaps even more common than fractures adjacent to the central target zone.[18] Pressures as great as 28.12 kg/cm can result from the dog's narrow teeth, and when applied perpendicularly to the thin, wide bones of the skull can easily cause punctures to the cranium. Skull fractures can often occur bilaterally or coexist with facial fractures due to the mechanism of a forceful bite gripping the head from two opposing sides.[32] Cranial fractures were more common in infants, where the skull-to-face ratio is much higher, which could contribute to an increased likelihood of sustaining injury to the scalp.

There is a pattern of late diagnosis with depressed skull fractures, often remaining unrecognized until complications such as abscess or meningitis appear.[25,32] Lacerations over the skull may be particularly deceptive, as underlying puncture fractures may not be obvious due to displacement of the scalp. Furthermore, both normal consciousness and absence of neurologic deficits do not appear to rule out penetration of the cranium.[32] It is possible that CT is underutilized in cases that present as punctures to the scalp through relatively small skin wounds.[35] All scalp lacerations must be thoroughly examined to exclude the possibility of a skull fracture. Similarly, small puncture wounds over maxillary or frontal sinuses may easily disrupt bone.[18,22,23,36] Comminuted fractures of the skull require

exploration and debridement, as they are more likely to be associated with dural lacerations.[32]

Orbital and alveolar fractures from these attacks tend to require additional procedures due to higher complication rates. Orbital fractures are often associated with ptosis or canthal tendon injury. Orbital and nasal bone fractures had high rates of epiphora and lacrimal duct damage often requiring tubing or dacrocystorhinostomy.[23] Periocular bite wounds tend to involve lacerations of the lid, canthal tendon, and canalicular system, and have the potential for damage to the globe and intracranial penetration as well.[37] Mandibular or maxillary fractures along the alveolus can cause dental injury, which may require additional procedures if permanent dentition is affected. Lacerations on either side of the mandible can be an indication that the bone was physically held between the dog's jaws and was subjected to high, sustained force.[28]

Dog bite fractures can demonstrate unique fracture patterns with significant comminution due to the mechanism of injury.[23,26,27] Despite the unique cause of injury, the authors favored using traditional methods of internal reduction and rigid fixation for displaced fractures. Nondisplaced fractures should be treated with routine closed reduction and soft diet. Because dog bite fractures occur primarily in the pediatric population, they tend to require special consideration for maturing facial skeleton, varying dentition, and fixation of an immature temporomandibular joint. Resorbable fixation is ideal for displaced fractures that are non–load-bearing, such as zygomatic and midface fractures. Mandibular fractures that are non–load-bearing can be treated with intermaxillary fixation, but this requires either adequate dentition or careful planning to avoid injury to un-erupted teeth. Rigid metallic fixation is acceptable and was preferred by the majority of surgeons in the present cases, but removal is recommended at 3 to 6 months to avoid plate migration and growth restriction.[38] Significantly displaced nasal fractures should be managed with closed reduction and splinting when possible, but minimally displaced fractures, especially in older children, may benefit from observant management to avoid further bone disruption with consideration for formal septorhinoplasty after the age of 16 years.[38]

Antibiotic coverage remains a controversial issue. Lackmann et al have suggested that any bite with bone involvement should be treated empirically with antibiotics.[19] The rate of infection among reviews of fracture cases was between 0 and 12%, and does not appear to be significantly higher than average for dog bites in general, which is typically less than 10%.[10,22,23,32] This may be because all cases with identified fractures are treated aggressively with antibiotics, but no untreated group is available for a comparison of infection rates. The most commonly used antibiotics for primary prophylaxis were ampicillin/sulbactam, cephalosporins, or clindamycin. If there is evidence of intracranial penetration, Steen et al recommend meropenem.[32] At this point, there is not enough information to provide further recommendations for antibiotic coverage and is an area for further research.

This study adds to the current body of knowledge, given the relative lack of information available and comparison to previously published research. Currently, case reports and several small case series were noted in our literature review. Case reports are subject to bias based on perceived rarity, which may contribute to the larger number of mandibular fractures, a fracture less commonly noted in case series. To our knowledge, there is only one prior study, conducted by Wei et al, of similar design to the present study as a retrospective chart review focused specifically on fracture rates in facial trauma caused by dog bites. Unlike Wei et al, we included the adult population in our analysis and found no patients with such injuries, indicating this is largely only a concern in pediatric populations. We also found a higher proportion of skull fractures which is one of the main controversies in the current literature; however, our studies did agree that these fractures largely occurred in children younger than 1 to 2 years.[12,23,34]

Our study was limited by the low rate of craniofacial fractures caused by dog bites. In reviewing the electronic medical records of our institution for 5 years, only a small sample size was generated and only pediatric cases were found. Additionally, we collected and filtered cases into groups and subgroups based on ICD-9 codes, and it is possible that if all codes were not entered in our electronic records by providers, facial fractures that did not require surgical intervention or facial dog bites without clinically significant fractures may have been missed in our review. Therefore, it is possible that our data are an underestimate of total cases. A review of literature was included to consolidate what is known of these types of fractures, although current literature is also largely limited to case series format without large, randomized trials. As such, much of our literature review is descriptive in nature, with the purpose of disseminating and summarizing information rather than evaluating study techniques or effectiveness of therapy. In an effort to develop a treatment protocol, a formal systemic review may be beneficial, given the relative difficulty of forming a single large study with the limited patient population.

Conclusion

Dog-bite–related fractures primarily occur in the very young patients at a rate of 1 to 5%, with little to no indication based on symptoms alone. Physicians must be very thorough when examining minor lacerations around the orbit, sinuses, and scalp. One fracture should prompt a search for additional fractures, especially when lacerations sustained from a large dog are present elsewhere on the scalp or face. As would be expected, fractures commonly occur in the "central target area," including nasal, zygomatic, orbital, and alveolar, but a high number of skull fractures were also found. There should be a low threshold for ordering CT scans with facial injuries following a dog attack, as failure to identify fracture may result in unnecessary disfigurement, infection, and secondary operations. Infants younger than 1 to 2 years with scalp lacerations or punctures should have a very high index of suspicion for underlying fracture. Due to young age, CT scans may currently be underutilized and many cases are delayed in diagnosis. Management of these injuries should include a multidisciplinary approach and focus on repair of soft tissue

and skeletal deformities, typically requiring washout and debridement in the operating room. Despite the unique cause of injury, authors favored using the traditional methods of internal reduction and rigid fixation for displaced fractures. Patients with facial fractures may benefit from hospital admission and intravenous antibiotics to prevent infection, though antibiotic use is controversial and additional studies are necessary. Furthermore, follow-up is advised to monitor for long-term complications especially for comminuted and displaced fractures associated with dentition or the orbit. The limitations of this study include the small sample size and retrospective nature.

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Conflict of Interest
None of the authors have any conflict of interest.

References

1 Foster MD, Hudson JW. Contemporary update on the treatment of dog bite: injuries to the oral and maxillofacial region. J Oral Maxillofac Surg 2015;73(05):935–942
2 Weiss HB, Friedman DI, Coben JH. Incidence of dog bite injuries treated in emergency departments. JAMA 1998;279(01):51–53
3 Shaikh ZS, Worrall SF. Epidemiology of facial trauma in a sample of patients aged 1-18 years. Injury 2002;33(08):669–671
4 Ozanne-Smith J, Ashby K, Stathakis VZ. Dog bite and injury prevention–analysis, critical review, and research agenda. Inj Prev 2001;7(04):321–326
5 Karlson TA. The incidence of facial injuries from dog bites. JAMA 1984;251(24):3265–3267
6 Touré G, Angoulangouli G, Méningaud JP. Epidemiology and classification of dog bite injuries to the face: a prospective study of 108 patients. J Plast Reconstr Aesthet Surg 2015;68(05):654–658
7 Harris D, Imperato PJ, Oken B. Dog bites–an unrecognized epidemic. Bull N Y Acad Med 1974;50(09):981–1000
8 Chen HH, Neumeier AT, Davies BW, Durairaj VD. Analysis of pediatric facial dog bites. Craniomaxillofac Trauma Reconstr 2013;6(04):225–232
9 O'Brien DC, Andre TB, Robinson AD, Squires LD, Tollefson TT. Dog bites of the head and neck: an evaluation of a common pediatric trauma and associated treatment. Am J Otolaryngol 2015;36(01):32–38
10 Hallock GG. Dog bites of the face with tissue loss. J Craniomaxillofac Trauma 1996;2(03):49–55
11 Morgan M, Palmer J. Dog bites. BMJ 2007;334(7590):413–417
12 Brogan TV, Bratton SL, Dowd MD, Hegenbarth MA. Severe dog bites in children. Pediatrics 1995;96(5, Pt 1):947–950
13 Griego RD, Rosen T, Orengo IF, Wolf JE. Dog, cat, and human bites: a review. J Am Acad Dermatol 1995;33(06):1019–1029
14 Jaindl M, Grünauer J, Platzer P, et al. The management of bite wounds in children–a retrospective analysis at a level I trauma centre. Injury 2012;43(12):2117–2121
15 Jaindl M, Oberleitner G, Endler G, Thallinger C, Kovar FM. Management of bite wounds in children and adults-an analysis of over 5000 cases at a level I trauma centre. Wien Klin Wochenschr 2016;128(9-10):367–375
16 Wiseman NE, Chochinov H, Fraser V. Major dog attack injuries in children. J Pediatr Surg 1983;18(05):533–536
17 Centers for Disease Control and Prevention (CDC). Dog-bite-related fatalities–United States, 1995-1996. MMWR Morb Mortal Wkly Rep 1997;46(21):463–467
18 Schultz RC, McMaster WC. The treatment of dog bite injuries, especially those of the face. Plast Reconstr Surg 1972;49(05): 494–500
19 Lackmann GM, Draf W, Isselstein G, Töllner U. Surgical treatment of facial dog bite injuries in children. J Craniomaxillofac Surg 1992;20(02):81–86
20 Schalamon J, Ainoedhofer H, Singer G, et al. Analysis of dog bites in children who are younger than 17 years. Pediatrics 2006;117(03): e374–e379
21 Palmer J, Rees M. Dog bites of the face: a 15 year review. Br J Plast Surg 1983;36(03):315–318
22 Wei LA, Chen HH, Hink EM, Durairaj VD. Pediatric facial fractures from dog bites. Ophthal Plast Reconstr Surg 2013;29(03):179–182
23 Tu AH, Girotto JA, Singh N, et al. Facial fractures from dog bite injuries. Plast Reconstr Surg 2002;109(04):1259–1265
24 Garvey EM, Twitchell DK, Ragar R, Egan JC, Jamshidi R. Morbidity of pediatric dog bites: a case series at a level one pediatric trauma center. J Pediatr Surg 2015;50(02):343–346
25 Froind S, Parra AS, Segal N. Delayed diagnosis of intracranial injury due to a dog bite–a case report and review of the literature. Int J Pediatr Otorhinolaryngol 2013;77(09):1400–1402
26 Baldi JR, Wolff de Freitas DA. Mandible and zygomatic fracture in a 2-year-old patient due to dog bite. Craniomaxillofac Trauma Reconstr 2013;6(02):137–142
27 de Carvalho MF, Hardtke LA, de Souza MF, de Oliveira Araujo V. Comminuted mandibular fracture in child victim of dog bite. Dent Traumatol 2012;28(04):324–328
28 Cottom H, Tuopar D, Ameerally P. Mandibular fracture in a child resulting from a dog attack: a case report. Case Rep Dent 2011; 2011:659756
29 Burns R, Kusanale A, Brennan PA. Penetrating skull and brain injury due to a dog bite: a cautionary tale for the unwary. Br J Oral Maxillofac Surg 2011;49(07):582–583
30 Walker T, Modayil P, Cascarini L, Collyer J. Dog bite- fracture of the mandible in a 9 month old infant: a case report. Cases J 2009; 2(01):44
31 Santana-Montero BL, Ahumada-Mendoza H, Vaca-Ruíz MA, et al. Cerebellar abscesses caused by dog bite: a case report. Childs Nerv Syst 2009;25(09):1137–1141
32 Steen T, Ravin K, Timmons S, Kershenovich A. Intracranial injuries from dog bites in children. Pediatr Neurosurg 2015;50(04): 187–195
33 Gurunluoglu R, Glasgow M, Arton J, Bronsert M. Retrospective analysis of facial dog bite injuries at a Level I trauma center in the Denver metro area. J Trauma Acute Care Surg 2014;76(05): 1294–1300
34 Mitchell RB, Nañez G, Wagner JD, Kelly J. Dog bites of the scalp, face, and neck in children. Laryngoscope 2003;113(03):492–495
35 Mason AC, Zabel DD, Manders EK. Occult craniocerebral injuries from dog bites in young children. Ann Plast Surg 2000;45(05): 531–534
36 Fourie L, Cartilidge D. Fracture of the maxilla following dog bite to the face. Injury 1995;26(01):61–62
37 Gonnering RS. Ocular adnexal injury and complications in orbital dog bites. Ophthal Plast Reconstr Surg 1987;3(04):231–235
38 Alhumsi TR, Gilardino MS. Current management of facial fractures in the preadolescent. Curr Opin Otolaryngol Head Neck Surg 2014;22(04):336–341