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ORIGINAL RESEARCH—PEDIATRIC OTOLARYNGOLOGY

Head and neck dog bites in children

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OBJECTIVES: 1) Demonstrate patterns of dog bite injury to the head and neck in children. 2) Identify treatment outcomes of dog bite injuries to the head and neck.

STUDY DESIGN: Case series with chart review.

SUBJECTS AND METHODS: Children aged 0 to 19 years, treated for head and neck dog bites at our tertiary care children's hospital (1999-2007), were included. Demographics, dog breed and ownership, seasonal incidence, wound location, characteristics, management, and complications were recorded.

RESULTS: Eighty-four children, aged 10 months to 19 years (mean, 6.19 years) underwent primary repair of head and neck dog bite injuries. The cheek (34%) and lips (21%) were involved most commonly. Average wound length was 7.15 cm. Dog bite incidence peaked during summer months. Infection occurred in 10.7 percent. Pulsed dye laser was used to improve cosmesis.

CONCLUSIONS: Children are vulnerable to head and neck dog bite injuries. Wound healing is excellent despite a contaminated wound. Infections occur infrequently. Pulsed dye laser improves cosmesis.

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A dog is man's best friend but potentially may be a child's worst companion. Among all injuries presenting to emergency rooms, about 1 percent are attributed to dog bite injuries. Of these, 44,000 are facial injuries that occur annually in the United States, according to the Centers for Disease Control.[1] Children are especially vulnerable to dog bite injuries to the head and neck region. This study examines patterns of head and neck dog bites injuries to generate awareness of the magnitude of these injuries presenting to a tertiary care children's hospital.

METHODS

We performed a retrospective computerized database search for dog bite injuries sustained to the head and neck that were treated by the department of pediatric otolaryngology at a tertiary care children's hospital. After approval from our institutional review board, we searched for all patients, aged 0 to 19 years, who were treated from 1999 to 2007 for head and neck dog bites. All charts were retrieved successfully and studied by three investigators conforming to a common data collection checklist for uniformity. Patterns of injury, surgical and medical management, outcomes, and associated complications were investigated. Though patients were handled by five pediatric otolaryngologists, all shared similar medical and surgical management principles and underwent regular departmental peer review. Patient demographics, dog breed and ownership, location of bite injury, seasonal incidence, wound characterization (eg, linear, complex, avulsion, puncture), management, and complications were recorded. Charts having incomplete data, which consisted mostly of unidentified dog breeds, were still included in the study since other recorded relevant data fulfilled the objectives of the study.

RESULTS

Eighty-four children, aged 10 months to 19 years, were treated for dog bites to the head and neck over an eight-year period. Mean age at presentation was 6.19 $\pm$ 4.01 years with a median age of 4.07 years. Forty-six patients were male and 38 were female, for a ratio of 1.2:1. Median follow-up after injury was 37 days (range 4 days to 4.4 years). Fifty-four patients (64%) suffered wounds to more than one location. Average total wound length was 7.15 cm. The most common sites of dog bites to the head and neck were cheeks (34%), lips (21%), and nose and ears (both at 8%) (Fig 1). Wound laceration patterns noted were complex (45%), linear (32%), avulsion (18%), and punctures (4%).

Most injuries occurred during warmer ambient temperatures (Fig 2) and were due to family pets (23/84; 27%). The Pearson correlation factor showed a high correlation between increased ambient temperature and incidence of dog bites ($r = 0.68$, Fisher test $> 95\%$ confidence). Among identifiable dog breeds in the study, pit bulls were responsible for a notable proportion of the injuries (11/84; 13%).

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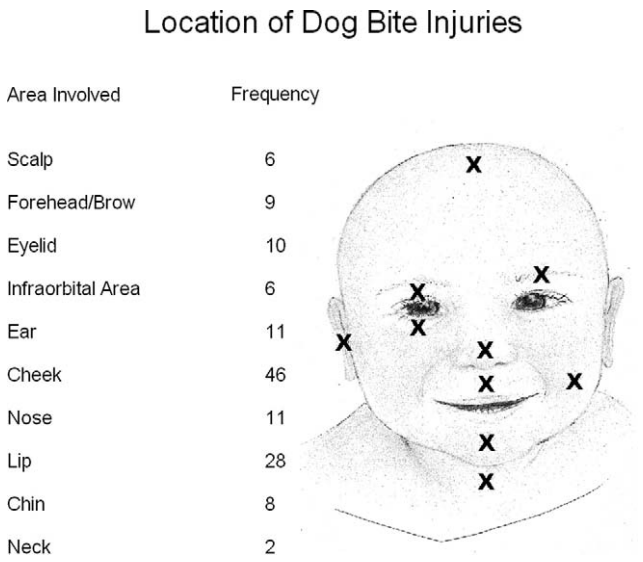

Figure 1 Location and frequency of dog bites.

Forty-nine wounds (58%) were repaired in the emergency room under local anesthesia with (13/49; 26%) or without (36/49; 74%) intravenous (IV) sedation. Thirty-five repairs (42%) were performed in the operating room under general anesthesia. Average wound lengths were as follows: 5.15 cm under local anesthesia only, 4.87 cm under local with IV sedation, and 10.13 cm under general anesthesia.

All wounds were treated with betadine, debrided, irrigated with saline, and closed primarily using a multiple layer closure with absorbable, subcutaneous suture and a nonabsorbable synthetic, monofilament cutaneous suture. Suture removal was performed at five to seven days. Broad-spectrum antibiotics were used in all cases.

Despite local irrigation/debridement, antibiotics, and primary closure, infections occurred in 10.7 percent (9/84) of patients. Average wound length among these patients who had postoperative infections was longer, averaging 9 cm compared to the study group average of 7 cm. Five underwent repair under local while four underwent general anesthesia. Two patients who had postoperative infections had cheek involvement and two involved avulsed tissue flap loss.

Complete avulsion of tissue occurred in four patients. In only one case was avulsed tissue not available for re-implantation. Avulsed tissue flaps that were reattached failed, eventually requiring careful local debridement and further healing by secondary intention.

Intravenous antibiotics (ampicillin-sulbactam at 200 mg/kg/day in divided doses) were infused an average of four days in all non–penicillin-allergic patients. Patients were sent home with a 10-day regimen of amoxicillin/clavulanate. Clindamycin was used in patients allergic to penicillin. One patient required iodoform packing after abscess formation on the fourth day after repair. Packing was removed completely after two days and the patient was sent home on a 10-day regimen of amoxicillin/clavulanate. Two additional patients developed cellulitis after noncompliance with the prescribed antibiotic regimens, but were managed with amoxicillin/clavulanate orally upon presentation.

Hypertrophic and hyperemic scars persisted in 12 patients (14%). In this study, 11 patients underwent pulsed dye laser (PDL) treatments for persistent hyperemic and hypertrophic scars and showed clinical improvement. Eleven cases underwent at least one PDL on an average of three months (range, 1-6 months) post repair, achieving desirable cosmesis by approximating the normal skin color of the scar. Two of these patients received a second PDL procedure to achieve better cosmetic results. Pulsed dye laser was delivered at an average of 9 Joules/cm^2 at 1.5-millisecond duration on a 7-mm spot under general anesthesia.

DISCUSSION

The American Pet Products Manufacturers Association reports that there were 74.8 million dogs in the United States in 2007. A national survey by the Centers for Disease Control in Atlanta, Georgia reported that dogs bite nearly 2 percent of the US population annually.[1] Dog bites result in 4.7 million injuries of which 800,000 require medical care,[2] with 10 to 20 fatalities[3] and 44,000 facial injuries[4,5] treated in US hospitals reported annually. This represents about 0.5 percent to 1.5 percent of all emergency room visits. In children under 10 years of age, the face, particularly the mid-face, is the most common target, representing 76 percent of injuries.[6] Dogs are known to favor the head and neck area when attacking children.[7] The head is thought to provide a convenient target for persistent mauling. The usual motivation of an attacking dog is believed to be aggression and its territorial behavior. But according to one such documentation, only 6.5 percent of the victim's behavior can be classified as provocative.[8] Children lack understanding to distance themselves from danger. Small children may even simulate prey to a watching dog, especially as they run around rapidly. They are often not able to outrun dogs or to

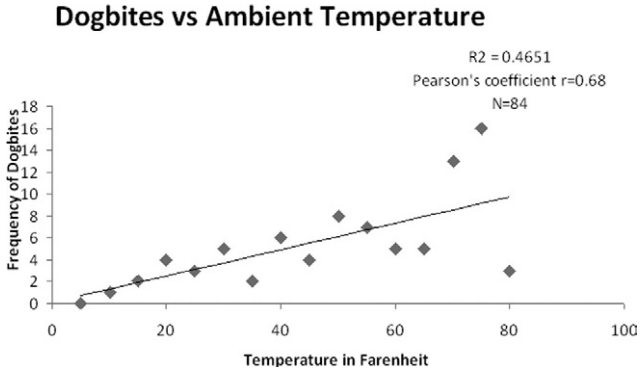

Figure 2 Dog bites and ambient temperature: Dog bites occurred with increased frequency during higher ambient temperatures. In Buffalo, NY, only 17% of daily average ambient temperatures are above 70 degrees Fahrenheit, while 38% of dog bites occurred during these elevated temperatures.

offer resistance against an attacking dog. Dog biting pressures exert considerable force of about 200 to 400 pounds per square inch, and even higher (at 1800 pounds per square inch) among pit bulls.[9-11] They may bite repeatedly and shake the victim vigorously, causing more trauma or "hole and tear" effect.[12] This explains a significant portion of injuries presenting as complex lacerations and avulsions. Encountered injuries involved mostly complex wound types that involve nonlinear wound patterns and include the deeper tissues such as muscles and fat. Superficial and deep linear wound patterns were also seen among patients. Occasional tissue loss from avulsion was also seen as a sequela of dog bite injury. To a lesser extent, puncture marks were also seen, which may not need repair but should be adequately cleaned and debrided. Dog bite injuries were mostly encountered on the cheeks, lips, nose, and ears. Deep scalp injuries, though not topping the list, had the most potential to bleed. The neck area was least involved among dog bite injuries. In our series, no mortalities resulted from dog bites.

The majority of biting dogs belong to the family or friend of the victim.[13] Twenty-seven percent of injuries were due to family pets. As reported in our study, pit bull terriers are the most commonly reported or identified breed causing the injury. Notoriety of the breed probably enables identification and documentation; however, the exact breed responsible for most dog bite injuries may not be known.

The incidence of dog bite injury in our study was highest during warmer ambient temperatures. This may be due to 1) increased exposure of playing children to dogs in the summer months during recess from school; 2) to irritability of dogs during higher ambient temperatures. While elevated ambient temperature may be associated with increased incidence of dog bites in children, further study is needed to determine causality.

The majority of our wound repairs (49; 58%), occurred in the ER under local anesthesia with or without IV sedation. The type of anesthetic and the location of the repair (ER vs OR) did not affect postoperative infection rates in our study. After careful wound irrigation and debridement, primary repair of head and neck wounds caused by dog bites achieved good wound approximation and healing among 90% of the victims. Despite a contaminated wound, complications such as infections were manageable. Amoxicillin/clavulanate was used in our department because of its activity against many of the bacteria in dog saliva, which include *Staphylococcus aureus, Streptococci, Pasteurella multocida*, and anaerobes.[14,15] Some reports indicate that primary repair of dog bites to the face carries no greater risk than delaying repair (healing by secondary intention).[16] Delayed repair is the traditional approach, especially for patients who present late; however, with facial lacerations, primary repair gives the best cosmetic and functional results.[17] Our postoperative infection rate was higher at 10.7% (9/84) compared to the lowest published rate of 1.6 percent as reported by Zook et al,[18] but lower compared to 14.7 percent reported by Palmer and Rees.[6] Good wound healing was eventually achieved following continuation of antibiotic regimen and local wound care. Avulsed tissue that was surgically reattached as a free graft was completely lost in all four cases, but was intended to serve as a biologic dressing to help promote wound healing. Re-implantation of this nonvital tissue acts as a biologic dressing and can help decrease wound size.[19] Secondary wound healing among these patients could have achieved similar effect without re-implantation and may need further evaluation in future studies.

Long-term complications of wound healing included hypertrophy and hyperemia of the scar, which was managed using a pulsed dye laser. The exact mechanism of action of the pulsed dye laser is unknown. Pulsed dye laser may be useful to improve cosmesis for hyperpigmented scars by targeting persistence of angiogenic stimuli and retarded capillary regression implicated in this problem. Laser-induced selective photothermolysis of microvasculature leading to hypoxia and collagenesis from decreased microvascular perfusion is a plausible explanation.[20] We recommend PDL treatments on select patients with persistent hyperemic, hypertrophic scars following repair of dog bites to the head and neck.

Accurate reporting and documentation of dog bites to local health authorities is important for prevention strategies. A weakness of our study is the incomplete data recorded in the medical records in detailing the dog bites. Commonly, the breed of dog was either not known or not documented by the examiners. Educating medical staffs such as doctors, nurses, and allied medical personnel on precise and adequate documentation to include circumstances surrounding the dog bite, such as provocation, adequacy of child supervision, breed of dog, sex of the animal, spay/neuter status, history of prior aggression of the dog, dog restraint, time of the event, patient's past histories of dog bites, dog ownership, location of dog bite occurrence, dog disposition, and rabies vaccination are important in identifying trends and to promote and develop prevention strategies.

CONCLUSIONS

Young children are particularly vulnerable to severe dog bite injuries confined to the head and neck area. These dog bite injuries can be extensive and can also be a risk to life, especially among small children. Good wound healing with adequate cosmesis is achievable despite the extent of injury. Adequate irrigation and debridement prior to primary repair of dog bite injuries is recommended. Infections can be kept to a minimum and almost always resolve with local wound care and antibiotics. Pulsed dye laser may be useful to improve cosmesis for hyperpigmented scars at a later phase during wound healing. With continued study, dog bites may be preventable in young children.

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Philomena Behar, MD, study design, data collection, writer, editing; **Angelo Monroy, MD**, study design, data collection, writer, editing; **Mark Nagy, MD**, data collection; **Christopher Poje, MD**, data collection; **Michael Pizzuto, MD**, data collection; **Linda Brodsky, MD**, study design, data collection, writer, editing.

FINANCIAL DISCLOSURE

None.

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