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An Algorithmic Approach to Operative Management of Complex Pediatric Dog Bites: 3-Year Review of a Level I Regional Referral Pediatric Trauma Hospital

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Background: Incidence of dog bites continues to rise among the pediatric population and serves as a public health threat for the well-being of children. Plastic surgeons are at the forefront of initial management and eventual outcome of these devastating injuries. This study set out to determine the nature of dog bite injuries treated over a 3-year period at a large level 1 pediatric trauma center.

Methods: A retrospective review of emergency room records of all pediatric patients (age, 0–18 years old) who sustained dog bites between January 2012 and December 2014 were gathered. All details about age of patient, location and severity of dog bites, type of dog breed, antibiotics given, and emergency versus operative treatment were recorded and analyzed.

Results: One hundred eight patients aged 5 months to 18 years old were treated in the emergency department after suffering dog bite injuries during the study period. The highest incidence of dog bites occurred in preschool children. The mean age for patients who required operative repair was lower than the mean age for patients who underwent primary closure in the emergency department. The location of injury was most commonly isolated to the head/neck region. Of the 56 cases that had an identified dog breed, pit bulls accounted for 48.2% of the dog bites, and 47.8% of pit bull bites required intervention in the operating room.

Conclusion: Children with large dog bite injuries require more immediate care in a level 1 pediatric trauma hospitals in order to optimize their hospitalization course and eventual outcome. (*Plast Reconstr Surg Glob Open* 2017;5:e1431; doi: 10.1097/GOX.0000000000001431; Published online 20 October 2017.)

INTRODUCTION

Over 4.5 million dog bites occur in the United States annually with an estimated 86% increase in the incidence of hospitalization over the past 2 decades.¹ In 2014 alone, roughly 1 million Americans required medical attention and over 28,000 people underwent reconstructive surgery as a result of dog bites according to the American Society of Plastic Surgeons.² Dog bites can lead to life- and limb-threatening infections in the pediatric population due to

the ischemic nature of the tissue loss or mixed bacterial contamination.³ The blunt injuries caused by large dogs such as pit bulls can lead to tissue loss and result in contractures or hypertrophic scars. Facial penetrating injuries can lead to loss of function with soft-tissue deformity of form and contour that require multiple surgical interventions and concomitant psychological trauma. Dog bites have accounted for 4% of all pediatric emergency visits and up to 40% of pediatric traumas.² A 2010 study performed by Agency for Healthcare Research and Quality, showed that the average cost of a dog bite–related hospital stay was \$18,200, about 50% higher than the average injury-related hospital stay, which together with work-related losses lead to over \$1 billion loss to the American economy annually.

Infants are more than 4 times as likely to be bitten by the family dog and more than 6 times as likely to be bitten in the head/neck region.^{4–8} Children are more vulner-

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able to injuries to the head and neck due to their shorter stature, their relatively large head size, and their lack of understanding and fear of dogs. Majority of dog bites can successfully be repaired in the emergency room with primary closure, whereas patients with complex lacerations, avulsions, and shearing injuries of the face require a visit to the operating room.⁹⁻¹¹ The aim of our study is to look at the experience of a regional referral level I trauma hospital to ascertain patterns in locations of wounds, dog breeds, and type of operative intervention that can lead to better algorithm for management of these complex set of patients.

MATERIALS AND METHODS

A retrospective study was performed at Maria Fareri Children's Hospital of Westchester Medical Center. This is a large tertiary care center with level I Pediatric Trauma designation. Institutional review board approval was obtained at New York Medical College and information on all the pediatric patients (age, 0–18 years old) who sustained dog bites between January 2012 and December 2014 was gathered. All the patients came through the emergency room at Maria Fareri hospital as a walk-in, transfer from outside hospital, or trauma activations. Data were gathered with regard to the age of patient, location, and severity of dog bites, type of dog breed, antibiotics given, and treatment administered. For patients who required operative intervention, operative reports and photographs were obtained and reviewed.

RESULTS

With exclusion of other type of animal bites, 108 charts from the emergency department were gathered documenting dog bites in the pediatric population. There were 61 males and 47 females identified. The mean age of all pediatric dog bite injuries was 6.5 ± 4.9 (range, 5 months to 18 years old). The highest incidence of dog bites occurred in preschool (33.3%) and grade school (31.4%) children and lower in infant (17.5%) and teenage (17.5%) populations. The mean age for patients who required operative repair (4.3 ± 3.5) was lower than the mean age for patients who underwent primary closure in the ED (6.9 ± 4.5 ; *P*value of 0.0172).

The location of injury was most commonly isolated to the head/neck region (59.2%). Most patients suffered multiple injuries to various locations within the head/neck region. The distribution of injuries is noted in Figure 1. About 30.5% of patients had isolated injuries to the upper and lower extremities. Finally, 5 patients had injuries to torso including groin area and 6 patients had injuries to more than 1 location (i.e., both face and extremities). About 17 different breeds of dogs were identified in the study. Of the 56 cases that had an identified dog breed, pit bulls accounted for 48.2% of the dog bites. Other common offending breeds include German Shepard (8.9%), Husky (5.3%), and small terriers (5.3%; Fig. 2). More importantly, 47.8% of pit bull injuries required operative repair, which was 3 times more than other breeds.

For injuries that required intervention, 42 patients (38.8%) received primary closure in the ED, and 23 pa-

Demographic data of cases and wounds

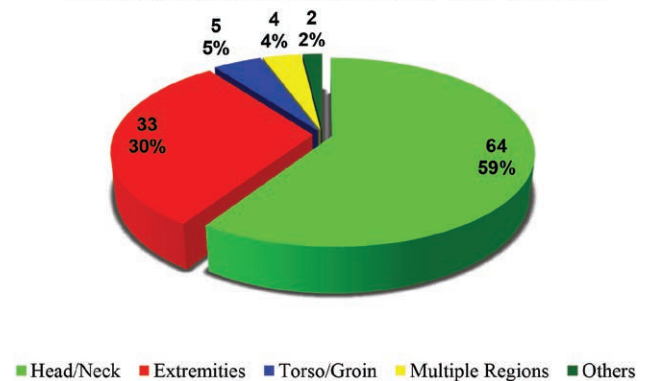


Fig. 1. Demographic data of cases and wounds.

tients (21.2%) needed operative repair. The emergency department physicians were able to primarily close to 10 patients with various absorbable/nonabsorbable sutures. For more complex lacerations and injuries, numerous consultations were obtained subspecialty services, including plastic surgery, oral and maxillofacial surgery, otolaryngology, orthopedics, ophthalmology, and pediatric surgery (Table 1).

Majority of patients received intravenous Unasyn (ampicillin/sulbactam) in the emergency room or during hospital stay and were discharged on oral Augmentin (amoxicillin/clavulanic acid) for an additional 7 days. For patients allergic to penicillin, alternatives included Bactrim (trimethoprim/sulfamethoxazole) and clindamycin.

There were no associated bony fractures in any of the dog bite injuries. There were also no mortalities in the study.

DISCUSSION

There have been numerous studies on pediatric dog bites to determine morbidity, prognosis, and social implications. One of the major aims of this study was to determine whether there is an association between the dog breed and frequency of dog bites, severity of injury, and treatment required. Several recent studies published from 2011 to 2016 have named pit bulls as the culprit of most common breed to inflict dog bites in pediatric population across the United States. More importantly, pit bulls are more likely to cause severe injuries that require operative repairs. O'Brien et al.¹² composed a Dog Bite Complication Index that grades severity of dog bite injuries based on size of laceration and extent of tissue, bone, and vascular involvement. In their study, they showed that pit bull bites caused significant injuries and were 5 times more likely to require operative repair compared with other breeds.¹² Gurunluoglu et al.¹³ showed in their study that pit bulls continued to be the most common breed to inflict facial dog bite injuries requiring direct and reconstructive repair despite legislation. Chen et al.¹⁴ from University of Colorado Denver showed that although pit bulls bites only accounted for 3% of all dog bites in their study, those patients suffered the most severe injuries and

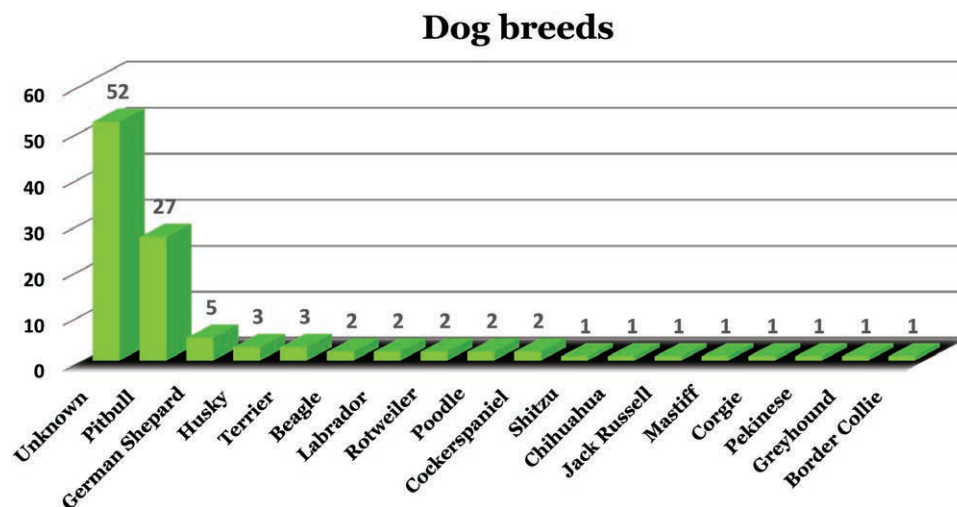


Fig. 2. Distribution of dog breeds.

Table 1. Types of Treatments

Treatment	n (%)
Intervention	
None	43 (39.8)
ED primary repair	42 (38.8)
Operative repair	23 (21.2)
Consultation	
Plastic surgery	27
OMFS	15
ENT	7
Ophthalmology	4
Orthopedics	5
Pediatric surgery	4

OMFS, Oral and maxillofacial surgery; ENT, ear, nose, and throat.

required the longest hospital stay. Focusing on the state where the study is based, statistics from the New York Department of Health reveal 6,600 children younger than 20 years old are treated at hospitals because of a dog bite injury, and more than 200 of them are injured severely enough to require hospitalization (3.3%).

The geography of the attacks varies as well. Surveys have shown that up to 50% of the dog bite cases result from household pet dogs.¹⁵ Children from ages of 9 to 12 years are the most common victims of these dog attacks.¹⁶ Further studies show that among 17 different breeds of dogs, pit bulls have the highest percentage (48.2%) of these dog attacks. After the pit bull, the German Shepard (8.9%) and Husky (5.3%) are the most common dogs that cause several severe injuries through their teeth. In our study, among the breeds that could be identified, pit bulls accounted for almost half of the dog bites. Pit bull bites also accounted for at least 11 of the 23 operative cases. Among the operative pit bull cases, 8 required local flap reconstruction and 2 required full-thickness skin grafting.

With regard to location of injury in pediatric population, many studies have shown that head and face wounds are more common in children below the age of 18 years. This may be explained by child's short stature, larger head circumference, and underdeveloped evasive motor skills to protect the face. In addition, injuries to the head and

neck more often will require surgical repairs in the operating room.^{12,14,17-19} Our data are consistent with others in that 59.2% of all cases of dog bites were noted in the head/neck region. Most of these cases required plastic surgical repair.

WESTCHESTER ALGORITHM FOR TREATMENT OF DOG BITES

Based on our experience treating pediatric dog bites in the Maria Fareri Children's Hospital, we have devised guidelines to treat dog bites based on the severity of the injury (Fig. 3). Simple puncture wounds and abrasions can be managed with wound irrigation and application of nonadherent dressing. Patient should follow up with pediatrician or surgical specialist in 3-5 days on outpatient basis. Simple or certain complex lacerations can also be repaired in the emergency room under local sedation (i.e., ketamine) and analgesic after thorough wound irrigation based on the child's tolerance level. These patients should also have outpatient follow-up within 1 week. Patient with complex lacerations unable to tolerate local sedation, partial flap avulsions, or complete full-thickness tissue loss require operative repair and hospital admission. For wounds with partial avulsions, any obvious necrotic tissue should be debrided. Any questionable areas should be allowed to demarcate over 48-72 hours. For complete tissue loss injuries, the wounds need to be debrided and any underlying bone fractures should be addressed. Reconstruction for partial and complete tissue loss based on the complexity of the wound and defect is left to the surgeon's discretion (Fig. 4). Finally, the use of prophylactic antibiotics in treatment of dog bites still remains a controversial topic. Depending on the study, incidence of infections in children after treatment for dog bites varies from 1-14%, with or without the use of antibiotics.^{18,20,21} We recommend broad-spectrum antibiotic coverage for all dog bite wounds that require operative intervention. Among the commonly used antibiotics are ampicillin/sulbactam and oral amoxicillin/clavulanate potassium.

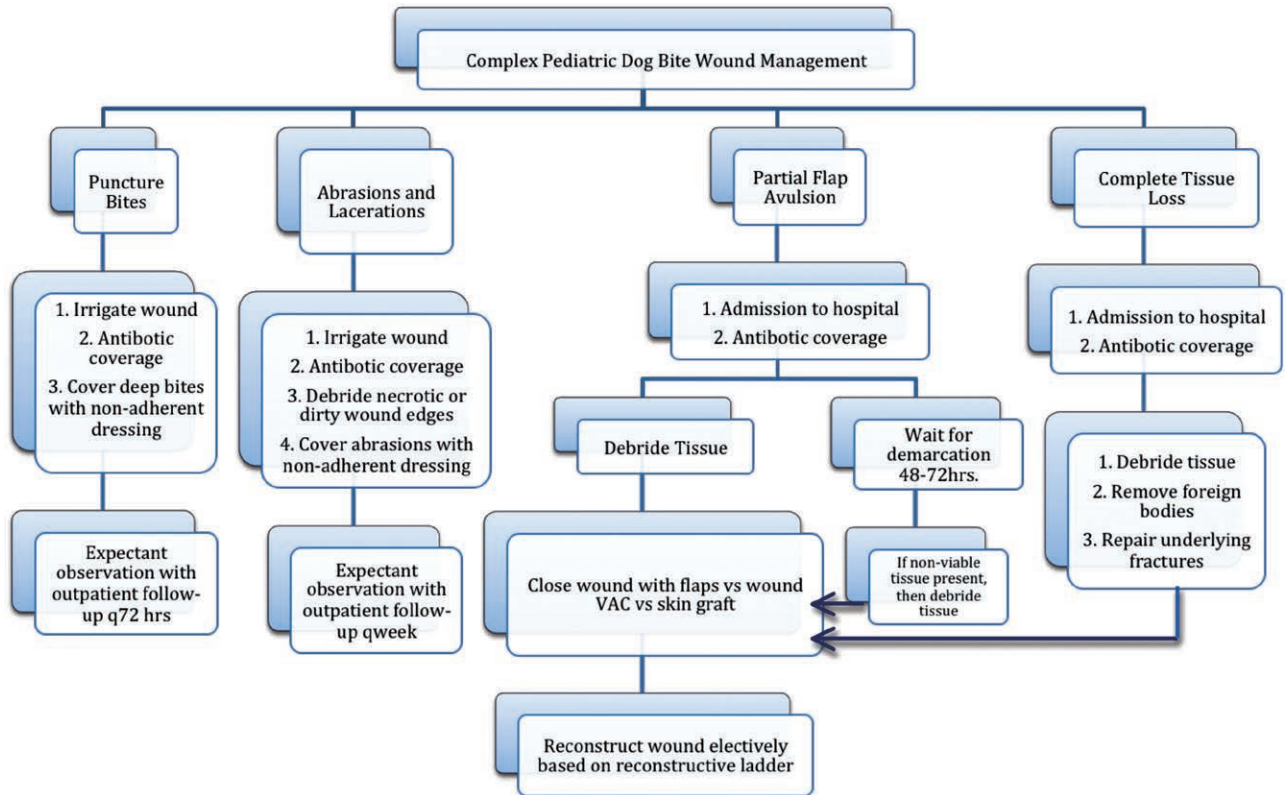


Fig. 3. Algorithm for treatment of pediatric dog bites.



Fig. 4. A facial dog bite injury in school age girl before repair.



Fig. 5. A facial dog bite injury in school age girl after repair.

Twenty-nine of 108 patients who presented to our hospital setting needed hospitalization after preliminary treatment based on the discussed treatment algorithm. Among these 29 patients, 20 patients (69%) were hospitalized for a short term of 1–3 days. Nine patients (31%) needed 4–11 days of extended hospitalization.

The biggest reason for extended hospitalization in these 9 patients was infection. Other reasons included reimplantation failure, concurrent injuries such as skull fracture and subarachnoid hematoma. Most of these patients were among the groups who received IV antibiotics

at the outside hospital for 48 hours without any improvement and was referred to Westchester Medical Center for further care. Most notable was that of the 9 patients with extended hospitalization, 6 (66.7%) were caused by a pit bull that confirms our theory that this breed results in the most devastating injuries at our center. The penetrating and crushing nature of these bites can lead to lifelong deformities (Figs. 4–7).

It is important to note that due to the retrospective nature of the medical record data, certain variables such as breed of dog could not be independently verified. Our



Fig. 6. An extremity dog bite injury in school age girl before repair with skin grafting.



Fig. 7. An extremity dog bite injury in school age girl after repair with skin grafting.

center may also have an inherent bias toward treating the most complicated cases that cannot be treated at a typical community hospital and therefore our data may be skewed toward the patient population with more devastating injuries caused by “larger biting dogs.” Similarly, we may have a bias toward under reporting of the post-

operative complications because many patients were referred from centers hours away and would have reported any outcomes-related issues to their primary doctor. In summary, dog bite injuries remain a common form of pediatric trauma that require medical attention, with potential psychological and emotional sequelae in children.¹² Hence, to address these injuries, it is of utmost importance to seek care at medical centers that have available trauma, plastic surgery, and psychological support services.

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PATIENT CONSENT

Parents or guardian provided written consent for the use of the patients’ images.

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