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Pediatric dog bite outcomes: infections and scars

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ABSTRACT

Background There is little consensus on the management of dog bite victims. Few studies have examined long-term patient outcomes. This study was designed to evaluate two outcomes: infection and unfavorable scar formation.

Methods A retrospective study of dog bite cases from January 2013 to May 2016 was conducted at our level I pediatric trauma center. Forty-five patients were identified who received definitive repair and had long-term follow-up for reasons other than rabies vaccination. Variables recorded were wound characteristics including presence of tissue loss, location in the hospital of the wound repair procedure, personnel performing the repair, postrepair infection, and a binary assessment of unfavorable scar formation.

Results Unfavorable scarring was not significantly related to either repair location or personnel. Rate of infection was not significantly related to repair location. However, infection rate was significantly related to personnel performing the repair (p=0.002), with 8 of 11 (73%) infections after repair by emergency physicians compared with surgeons.

Discussion The presence of infection was significantly related to bedside repair by emergency physicians. The data are suggestive of differences in wound preparation and repair technique between emergency department and surgical personnel. Standardizing technique could reduce infectious complications and long-term morbidity associated with repairing dog bites and other contaminated wounds. A robust and practical classification system for dog bite wounds would be helpful in stratifying these wounds for research comparison and healthcare triage.

Level of evidence The level of evidence for this retrospective study is level III.

BACKGROUND

Pediatric dog bite injuries are a common public health concern in the USA. Approximately 4.5 million dog attacks occur each year, with children accounting for half of the cases.[1] Dog bites account for up to 40% of all pediatric traumas and 3% to 4% of all pediatric emergency department (ED) visits.[2] Of attacks in children or adults, 81% do not require medical attention. However, this still leaves 855 000 cases per year that require treatment.[1] The Centers for Disease Control and Prevention estimates that more than 310 000 dog bite-related injuries are treated each year in the ED, with the rest treated in other medical settings.[3] Of these ED visits, 96% of presenting injuries are considered minor. Although dog bite operations are among the top five reconstructive procedures performed by plastic surgeons, this amounts to only 27 000 annual repairs. ED physicians and primary care providers are the vital front line in the treatment of dog bite injuries.[4]

Wounds from dog bites are often complex and can present as a combination of lacerations, punctures, avulsions, and crushed tissue. Some wounds may not appear severe externally if the superficial tissue remains intact. But the underlying tissue may be devitalized by tearing, crushing, or avulsing of the supporting blood supply.[5] These features in bites can lead to a longer inflammatory phase of healing compared with other wound types, increasing the risk for pathological scarring.[6] In addition, children are at particularly high risk for scar hypertrophy from the age of 2 through the end of puberty.[7] One study reported 91% of dog bite victims having aesthetic sequelae, and 31% considering these sequelae handicapping.[8]

Dog bites also contain polymicrobial flora from a combination of the environment, mouth of the dog, and skin of the victim.[9] This makes primary closure of dog bite wounds controversial. In some studies, primary closure with various forms of wound decontamination has not shown increased rate of infection compared with healing by secondary intention.[10–12] However, some patients with higher risk for infection were excluded. Improved aesthetic outcomes have also been shown with primary closure.[10 11 13]

Despite a growing body of research, the level of evidence for dog bite wound care is not strong enough to standardize care. Dog bite wound complexity and range of severity, along with variable clinical experiences, have also led to a lack of consensus on the optimal management of dog bite victims. A first step in optimizing management is to explore outcomes. Many valuable studies have been conducted exploring demographics, wound characteristics, and breeds surrounding dog bites. However, only a relative few have examined long-term patient outcomes. The purpose of this study was to compile long-term follow-up information on pediatric dog bites and trace outcomes back to management decisions. This study evaluates two outcomes: infection and unfavorable scarring. One recent study by Essig *et al*[14] examines the influence of repair location on infection and cosmesis. In our study, we additionally investigate outcomes as they relate to the personnel performing dog bite wound repairs.

METHODS

A retrospective study of dog bite cases from January 2013 to May 2016 was conducted at our level I pediatric trauma center. A chart review was performed

of all 680 patients who presented with dog bites during this period using the hospital's electronic medical record (EMR). Of these patients, 144 had returned to the outpatient clinic for follow-up. If follow-up information was missing or unavailable in the patient's EMR, hard copies of the medical record were sought in the pediatric surgery and plastic surgery clinics. Patients were excluded from analysis if follow-up information was incomplete. Forty-five patients were identified who received definitive repair and had long-term follow-up for reasons other than rabies vaccination. Variables recorded were wound characteristics including presence of tissue loss, location in the hospital of the wound repair procedure, personnel performing the repair, postrepair infection, and a binary assessment of unfavorable scar formation. Wound repair locations included the operating room, the bedside in the ED, or a combination of the two locations. Personnel performing the procedure were attendings or residents with either emergency medicine training or surgical training. Unfavorable scarring was defined as the presence of hyperpigmentation, hypervascularity, hypertrophy, and/or contracture requiring additional medical or surgical scar modification interventions. Statistical analysis was performed using Fisher's exact test. There were three patients who had their wounds repaired in a combination of locations and were not included in the statistical analysis.

RESULTS

Patient ages ranged from 14 months to 14 years old. The mean age was 7.7 years. Follow-up ranged from 1 week to 112 weeks, with the median length of follow-up at 6.9 weeks.

Of the 45 total patients, 18 were repaired in the operating room, 24 in the ED, and 3 in both locations (table 1). Of 18 patients undergoing operative repair, 8 (44%) had wounds involving tissue loss, 2 (11%) developed infection, and 12 (67%) developed unfavorable scarring.

Of patients treated at the bedside in the ED, 10 were treated by surgeons and 14 by emergency physicians. None of the patients repaired in the ED had wounds involving tissue loss. After repair by a surgeon, 1 of 10 (10%) patients developed infection and 6 of 10 (60%) developed unfavorable scarring. After repair by an emergency physician, 8 of 14 (57%) patients developed infection and 7 of 14 (50%) developed unfavorable scarring.

There were 11 total infections in the group of 42 patients with single location repair. Infections developed in 9 of 24 (37%) patients repaired at the bedside and in 2 of 18 (11%) repaired in the operating room. Of the 11 patients who developed wound infections, 10 developed unfavorable scarring. There were eight patients with tissue loss, and all eight were repaired in the operating room, seven of whom developed unfavorable scarring.

There were 25 patients who developed unfavorable scarring, 15 of whom (60%) had either infection, tissue loss, or both. Of the remaining 17 patients who did not develop unfavorable scarring, only 1 (6%) had an infection and 1 (6%) had tissue loss (figure 1).

All statistical analyses were performed excluding the three patients who had their wounds repaired in a combination of locations. Location of repair and tissue loss were significantly related (p=0.001), with 8 of 8 (100%) wounds with tissue loss repaired in the operating room. Unfavorable scarring was not significantly related to either location of repair or personnel performing the repair (figure 2). Rate of infection was not significantly related to location of the repair. However, infection rate was significantly related to personnel performing the repair

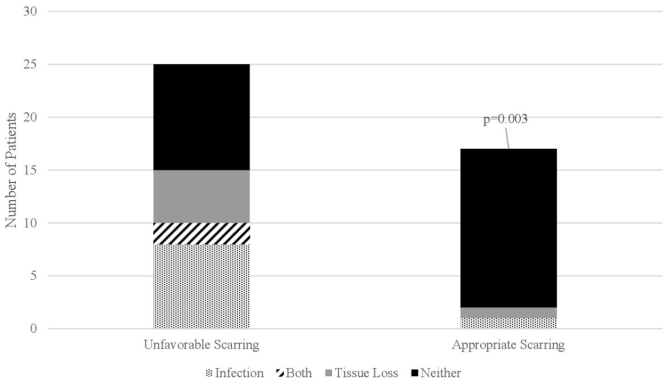

Figure 1 Presence of infection and/or tissue loss with an outcome of unfavorable versus appropriate scarring.

(p=0.002), with 8 of 11 (73%) infections after repair by emergency physicians (figure 3).

The presence of infection and/or tissue loss was significantly related to unfavorable scarring (p=0.003) (figure 1).

DISCUSSION

The purpose of this study was to compile long-term follow-up information on pediatric dog bites and to trace outcomes back to management decisions. The two interdependent outcomes under analysis are infection and development of unfavorable scarring. A related study by Essig *et al* demonstrated no significant difference in infections or cosmesis after repair of facial dog bite wounds by surgical subspecialists in either the operating room or bedside in the ED. The current study examines personnel performing repair in addition to repair location.

At a glance, the long-term outcomes for these patients seem indistinguishable regardless of the categories compared. Patients repaired in the operating room developed unfavorable scarring as often as those repaired at the bedside (figure 2). Suturing by emergency physicians did not result in a higher rate of unfavorable scarring than suturing by surgeons. However, there are relationships that suggest differences in etiology for the morbidity. All patients who eventually had unfavorable scarring after repair by emergency physicians had developed a wound infection in their postrepair course, likely leading to suboptimal healing and scar formation. Patients who developed unfavorable scarring after repair in the operating room more often had tissue loss and less often a wound infection as the etiology for their scar formation. It appears that scars developing after repair by surgeons

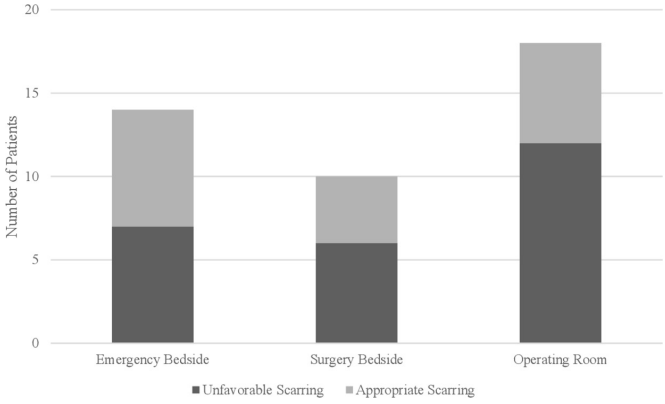

Figure 2 Scarring after repair in different locations or by different personnel.

Table 1 Data on wound repair decisions (including location and personnel) with outcomes and wound characteristics

	Bedside			Operating room	Combination
	All	Surgery	Emergency		
Repair (n=45)	n=24	n=10	n=14	n=18	n=3
Tissue loss	0	0	0	8	1
Infection	9	1	8	2	1
Scarring	13	6	7	12	1
Scarring + tissue loss	0	0	0	7	0
Scarring + infection	8	1	7	2	0

were more likely due to initial wound severity, whereas scars after repair by ED physicians were more likely due to postrepair infections of less severe wounds.

Both infection and tissue loss are associated with scar formation. As one cannot change the extent of tissue loss with which a patient may present, reducing the rate of wound infection after repair is a worthwhile pursuit. In this study, there is a significantly higher rate of infection in dog bite wounds after repair by an emergency room physician. Repairs done by surgeons at the bedside were not associated with the same rate of infection. Although a small sample size was studied, the data are suggestive of differences in wound preparation and repair technique between ED and surgical personnel. Hundreds of thousands of children bitten by dogs are effectively treated in EDs each year. A solution to the problem of infection is not to refer all dog bites to surgeons for repair, but to enhance the technique in EDs. It will be important for surgical and emergency personnel to discuss standardized technique (eg, prepping, draping, irrigating, and suturing) and together develop competencies and a repair protocol. This could reduce infectious complications associated with closing dog bites and other potentially contaminated wounds. Decreasing infections may affect the rate of unfavorable scarring in patients with dog bite wounds repaired in the ED.

In addition to standardizing technique, optimizing triage of dog bite wounds may also decrease infection rate. Current dog bite classification systems are often too simple or inflexible to properly reflect the clinical scenario. Creating a practical dog bite wound classification tool would help objectify the decisions to consult surgery or enter the operating room, encouraging both specialty care for those who need it and the optimization of medical resources. The tool would also allow better comparison of outcomes controlled for wound severity.

This study is affected by selection bias. The follow-up inclusion and exclusion criteria select for patients with either severe wounds or with wounds that developed complications. Although this intentionally allows analysis of poorer outcomes, it limits generalizability to all dog bites. The study's small sample size is also limiting. However, the selection criteria do increase its effect size. Another limitation is that there was only rough stratification based on wound severity using tissue loss as a severity marker. The idea that ED physicians repaired less severe wounds is not certain. Finally, surgical and non-surgical physician level of training was not recorded for wounds repaired in the ED.

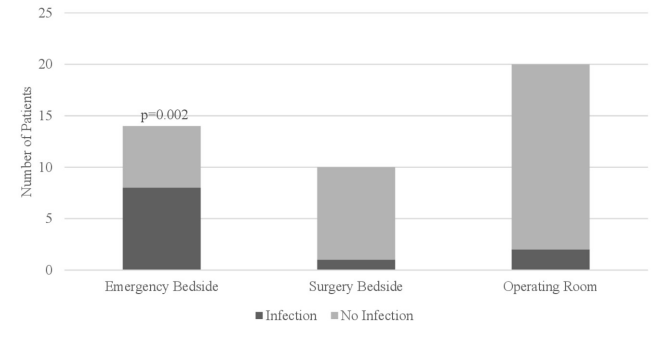

Figure 3 Infectious complications after repair in different locations or by different personnel.

CONCLUSION

Dog bites result in wounds of different severity and complexity. Whether the wounds are simple enough to repair at the bedside or more complex to need repair in the operating room, it is essential to strive to reduce wound infection. The presence of infection was significantly related to bedside repair by emergency physicians. The data are suggestive of differences in wound preparation and repair technique between ED and surgical personnel. Standardizing technique could reduce infectious complications and long-term morbidity associated with repairing dog bites and other contaminated wounds. A robust and practical classification system for dog bite wounds would be helpful in stratifying these wounds for research comparison and healthcare triage.

Contributors Study conception and design: BB, LD, CS. Data acquisition: BD, BB. Analysis and data interpretation: BD, BB, AR, CS. Drafting of the article: BD, BB. Critical revision: BD, AR, CS.

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Competing interests None declared.

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Data availability statement Data are available upon reasonable request. Data for this study is in a deidentified database and available for use for analysis verification only. For further information, contact PI Christina Shanti, MD at Children's Hospital of Michigan Pediatric Surgery Division, 3901 Beaubien Boulevard, Detroit, MI 48201.

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