Primary Closure of Mammalian Bites

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Abstract. **Objective:** Suturing of bite wounds remains controversial. The authors evaluated the incidence of wound infection in 145 mammalian bite wounds treated with primary closure. **Methods:** Consecutive patients with bite wounds receiving primary closure at a university hospital ED had structured closed-question data sheets completed at the time of wound management and suture removal. Infection was determined at the time of suture removal using a previously validated definition. Data included demographics; medical history; time from injury to evaluation; wound characteristics and location; details of wound cleansing methods, debridement, foreign body removal, and wound closure methods; use of antibiotics; and follow-up wound evaluation. Proportions and 95% confidence intervals were calculated. **Results:** One hundred forty-five mammalian bite patients were enrolled: 88 dog, 45 cat, and 12 human bites. Patients had a mean (±SD) age of 21 ± 20 years; 58% were male; 86% were white; and they presented a mean (±SD) of 1.8 ± 1.2 hours after injury. Bites occurred on the head and neck (57%), upper extremity (36%), and lower extremity (6%). Wounds had a mean length and width of 2.5 cm and 4.8 mm, respectively. Twelve percent involved structures deep to subcutaneous tissue. After primary wound closure, wound infections occurred in eight patients (5.5%; 95% confidence interval = 1.8% to 9.2%). **Conclusions:** The data suggest that carefully selected mammalian bite wounds can be sutured with approximately a 6% rate of infection. This infection rate may be acceptable in lacerations where cosmesis is a primary concern. **Key words:** lacerations; wounds, mammalian bites; dog; cat; human; infection. ACADEMIC EMERGENCY MEDICINE 2000; 7:157–161

EACH year, up to 4.5 million Americans are bitten by animals.[1] Bites account for 5% of the total traumatic wounds evaluated in the ED[2] and approximately 1% of all ED visits.[3,4] Dog bites account for the majority of these wounds. The treatment of mammalian bite wounds remains controversial. Clinical reports in the 1920s and 1930s initially described such severe infections of human bite wounds that the recommended treatments included radical skin excision, electrocautery, and nitric acid burns. It wasn't until the 1950s that antibiotics and primary closure of bite wounds were described.[5] More recent investigations support closure[6–12]; however, the numbers of patients with sutured wounds in these studies were small. Clinical trials and microbiologic analyses have emphasized antibiotic use to prevent wound infections.

Wound closure generally improves cosmetic outcome, especially in large gaping lacerations or avulsions.[7] Unfortunately, primary closure may also increase infection rate, a worrisome complication with potential sequelae, including septic arthritis, osteomyelitis, endocarditis, and septic shock. Clean, nonbite lacerations repaired in the ED have approximately a 3–7% infection rate.[2,11–15] Bite wounds, by definition, are dirty wounds and would be expected to involve a higher incidence of infection; however, the risks and benefits of wound closure have not been clearly delineated in the literature. The purpose of this report is to describe our experience with primary closure of selected mammalian bite wounds.

METHODS

Study Design. We conducted a prospective observational cohort study to determine the safety of traumatic wound closure in selected mammalian bite wounds. The study was approved by the University Medical Center Research Committee and the State University of New York Committee on Research Involving Human Subjects.

Study Setting and Population. This study was conducted in the ED of University Medical Center at Stony Brook, an academic tertiary care facility with an annual ED census of 47,000 patients. Patients who presented between October 1992 and August 1996 with lacerations were prospectively

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entered into our wound registry. The ED had trained research assistants who identified and enrolled all potential study subjects during the hours between 8 AM and midnight.[16] Between midnight and 8 AM, patients were identified and enrolled by the physicians and nurses caring for the patient. Based on quality assurance data, approximately 90% of all eligible patients with lacerations were enrolled in the wound registry through these mechanisms.

Patients who presented to the ED with a mammalian bite resulting in one or more lacerations were eligible for inclusion in the wound registry. Patients were excluded if they did not receive primary wound closure or required repair by a surgical subspecialist. There were no specific exclusion criteria based on time from injury until wound closure.

Study Protocol. Clinical data for each subject were prospectively recorded on a standardized wound registry data collection instrument at the time of initial presentation and at the time of suture removal.[2] Information recorded included patient demographics (age, sex, race, and the presence of any immunocompromising conditions); wound characteristics (mechanism of injury, time of injury, wound location, length, depth, shape, and margin, presence of contamination or foreign bodies); wound preparation (type of irrigant, method of irrigation, volume of irrigant, use and type of scrub, debridement); and wound closure techniques (use of deep sutures, type of closure, number and type of superficial sutures, use of local or systemic antibiotics, and type of wound dressing). The descriptive criteria of wounds have been shown to have excellent interpractitioner concordance (kappa ranging from 0.55 to 0.97) when applied by either physicians or physician extenders.[2] Each practitioner was assigned a unique identification code. There was no specific attempt to standardize wound care.

At the time of suture removal and follow-up, patients were evaluated by a physician or a physician extender, and the cosmetic appearance of the wound was rated using a reliable six-point scale that has previously been validated.[2,17,18] Practitioners who evaluated wound outcomes were blinded to the treatment method, except in the rare instance in which the evaluating physician also performed the primary wound closure. Because physicians in the study ED worked an average of only two shifts per month in the immediate care area where the majority of suturing was performed, they rarely followed-up patients whom they sutured. Patients who did not return to the ED for follow-up were contacted by telephone to determine whether they developed an infection.

Measures

Wound Infection. Wound infection was defined as the presence of either a stitch abscess, cellulitis more than 1 cm, or purulent drainage.[2,14,15,19,20] The clinical diagnosis of infection using this grading scheme has been shown to have excellent interobserver concordance.[2] For patients who do not return to the ED for suture removal, the diagnosis of infection necessitates treatment with antibiotics by another health care provider.

Cosmetic Scale. During the course of this study a cosmetic scale was devised.[2] Lacerations were assigned 0 to 1 point each for the presence or absence of the following: a step-off of borders; contour irregularities; wound margin separation; wound edge inversion; excessive wound distortion; and overall appearance. A total cosmetic score was then calculated by adding the individual scores on each of the six categories.[2] This scale has been shown to have a high degree of interrater reliability[2,18] and to correlate with the patient's own assessment of the cosmetic results.[17] In accordance with previous studies, wounds receiving a score of 6 were considered to have an optimal cosmetic appearance.[2,17,18] All other wounds were considered to have a suboptimal appearance.

Data Analysis. Data were entered into Access 95 (Microsoft, Inc., Redmond, WA) and imported into SPSS 8.0 for Windows (SPSS, Inc., Chicago, IL) for statistical analysis. Categorical variables are presented as frequency of occurrence and were compared using chi-square tests. Continuous variables are presented as means ± standard deviations and comparisons were performed using analysis of variance (ANOVA). Ninety-five percent confidence intervals are provided, where appropriate.

RESULTS

During the study period, 5,554 laceration repairs were entered in the wound registry. Of these, 145 mammalian bite patients received primary wound closure in the ED. Patients were predominantly male (58%) and white (86%). The mean (±SD) age of the patients was 20.8 ± 19.7 years, with a range of 0–93 years. No immunocompromised patients were enrolled in the study. There were 88 dog bites (61%), 45 cat bites (31%), and 12 human bites (8%). The patients presented a mean (±SD) of 1.77 ± 1.3 hours (range, 0–7 hours) following the injury.

Bite Characteristics. The lacerations were located predominantly on the head and neck (57%), upper extremity (36%), and lower extremity (6%). Two lacerations were located on the trunk (1%). The wounds had a mean (±SD) length of 2.5 ± 2.0

TABLE 1. Summary of the Eight Patients Who Developed Infections

ID Number	Age (Yr)/Gender	Time from Injury	Type of Bite	Location*	Irrigation or Scrub	Initial Antibiotic Treatment
1-229	2/Male	—	Dog	Head	Both	Augmentin
1-263	22/Male	2 hours	Dog	Upper extremity	Irrigation	Yes†
1-344	6/Female	—	Dog	Head	Irrigation	Augmentin
1-958	10/Male	<1 hour	Dog	Head	Irrigation	Augmentin
2-556	47/Female	—	Cat	Upper extremity	Irrigation	Augmentin
2-899	35/Male	1 hour	Cat	Upper extremity	Neither	Augmentin
3-1265	7/Male	3 hours	Human	Head	Irrigation	Augmentin
3-1422	61/Female	1 hour	Dog	Upper extremity	Irrigation	Augmentin

*Head includes facial lacerations.
†Choice of antibiotic not noted.

cm and a width of 4.8 ± 5.2 mm. All of the mammalian bite wounds penetrated the dermis, with 12% extending beneath the subcutaneous tissues. The lacerations more often had smooth margins (59%) than jagged margins (41%). The lacerations were most commonly linear (71%), although 22% were stellate and 7% were nonlinear. Most often, the lacerations were not aligned with skin tension lines (69%). Thirty percent of the lacerations had visible contamination, and 2% of the lacerations contained a foreign body that was removed.

Dog, cat, and human bites were similar with respect to almost all wound characteristics. The only differences were that the cat bites were more likely to be aligned with skin tension lines than were the dog or human bites (45% vs 19% vs 17%; p = 0.03) and the cat bites were more likely to have visible contamination (48% vs 24% vs 25%; p = 0.02).

Wound Management. Most of the bite wounds were treated with high-pressure irrigation (87%), usually with a syringe and needle. Some patients received local scrubbing (40%) of the laceration alone or in combination with high-pressure irrigation. Surgical debridement was performed in 24% of the bite wounds. The wounds were closed with 4.7 ± 3.8 skin sutures. Sixteen percent of the patients received deep sutures in addition to skin closure. Eighty-one percent were discharged with some form of oral antibiotics. Patients who received oral antibiotics were more likely to have received high-pressure irrigation (91% vs 70%; p = 0.01) and were more likely to have upper-extremity lacerations (41% vs 12%; p = 0.02). The two groups were otherwise similar. The infection rates did not differ between patients with and without prophylactic antibiotic treatment. There was no difference in wound management between the patients with dog, cat, and human bites.

Wound Outcome. Of the 145 mammalian bite patients, eight (5.5%) developed infections (95% CI = 1.8% to 9.2%). A summary of the eight patients who developed infections is provided in Table 1. Five of the infections were due to dog bites (5.7%; 95% CI = 0.9% to 10.5%), two were due to cat bites (4.4%; 95% CI = 0.1% to 10.4%), and one infection occurred following a human bite (8.3%; 95% CI 0.1% to 23.9%). Because the cosmetic scale was developed during the study period, only 39 patients had assessment of the short-term cosmetic outcome. Twenty-seven of these patients (69%; 95% CI = 55% to 83%) had optimal cosmetic outcomes.

DISCUSSION

Dogs, cats, or humans account for most mammalian bite wounds. Most bite wounds are minor, with only approximately 20% brought to medical attention.[4] Bite wounds include superficial abrasions, lacerations, and puncture wounds. The larger teeth of dogs facilitate the tearing of tissue, thereby causing more lacerations (31–45%) and superficial abrasions (30–43%) than punctures (13–34%).[6] Cats have fine, sharp teeth and a weaker biting force, resulting in more puncture wounds. However, these sharp teeth penetrate easily into tendon sheaths, bones, and joints, potentially increasing the risk of tenosynovitis, septic arthritis, and osteomyelitis.[4] Human bites present most commonly as lacerations on the dorsum of the hand.[21–23] These wounds usually occur when a closed fist strikes the teeth of an opponent and injures the metacarpophalangeal joints. In prior series of mammalian bites treated predominantly without wound closure, the extremities were most commonly involved (54–85% from dogs, 60–67% from cats, 46% from humans), upper more than lower, followed by the head and neck (15–27% from dogs, 15–20% from cats, and 33% from humans) and trunk (10% from dogs, 5% from cats, 22% from humans).[6,21] Facial injuries are more common in younger age groups.[6] Our study population included a larger preponderance of head and neck wounds representing the inclusion of the pediatric patient population. This may have produced a bias toward primary closure of lacerations in cosmetically important locations.

The focus of the majority of research on mam-

malian bite wounds has been on the use of prophylactic antibiotics to prevent infection. Infection rates depend on type of animal bite, location of wound, time until wound management, type of wound, and subsequent wound care, including closure and use of antibiotics. Based on several prospective, randomized trials, the overall infection rates of these wounds range from 0.53–47%.[5,7,8–10,12,24–29] In contrast, sutured nonbite wounds have infection rates of 3–7%.[2,11,13]

The effect of primary wound closure on the likelihood of developing infection following mammalian bite wounds has not been well studied. The largest series of data exists for dog bites. In a retrospective study of 106 dog bite patients, Callaham found that 2.9% of sutured wounds were infected, as opposed to 26% of open wounds.[30] In a separate study of 57 patients, Callaham reported an infection rate of 16.6% in sutured lacerations vs 6.25% in open wounds.[27] Others have found that infection rates (8%) for dog bites are similar whether or not primary closure is performed.[8] In a series of 91 patients with primary closure of dog bites, Dire et al. found a 4.4% infection rate.[29] Facial, head, and dog bite wounds, even when closed primarily, have the lowest infection rates at 1.47% (0.53% with antibiotics).[10] Data are considerably more sparse for cat bites, where Dire noted no infection following primary closure in eight patients with cat bite wounds.[24]

Data are limited on the treatment of human bites with primary closure. Although prophylactic antibiotics have been shown to decrease the risk of infection following human bites,[9] human bite wounds on the face are considerably less likely to develop infection with or without primary wound closure.[5]

To the best of our knowledge, our study is one of the largest cohorts of sutured mammalian bites. Of 145 patients who had lacerations repaired with primary wound closure, only 6% developed infections. The standard sutured wound infection rate during the same time frame, in the same institution, was 3.4%. Although this represents an increased rate of infection in bite wounds relative to nonbite wounds, we consider this acceptable for wounds in which the cosmetic outcome is important. Sixty-nine percent of the bite wounds to receive primary closure in this series had optimal cosmetic outcomes. This result is similar to those found in larger studies of predominantly nonbite lacerations.[2,17,18] In our opinion, the slightly increased risk of infection from closure of a mammalian bite wound is outweighed by the increased likelihood of obtaining an optimal cosmetic outcome when primary closure is performed, especially when the treatment of those patients who develop infections is usually simple.

Limitations and Future Questions

This study has several limitations that must be addressed. Our study population sustained predominantly dog bites, which are generally believed to be at lower risk of infection than human or cat bites. Neither local wound care nor the decision to perform primary closure was standardized. Some patients received treatment with antibiotics at the time of primary wound closure. The use of antibiotics was not standardized and cultures of infected wounds were not obtained. This study was performed prior to the introduction of tissue adhesives and therefore cannot be generalized to include their use. Finally, cosmetic outcomes were not assessed in most patients because the validated cosmetic scale was developed during the study period, and the cosmetic outcome that was assessed was short- rather than long-term appearance.

A randomized controlled trial comparing primary wound closure and delayed primary closure with respect to short-term infection rate and long-term cosmetic outcome would be the best method to define the patient population most likely to benefit from primary closure following mammalian bite wounds.

Conclusions

We have demonstrated that some mammalian bite wounds can be sutured with an approximately 6% rate of wound infection. This infection rate is probably acceptable for lacerations where cosmesis is the primary concern.

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REFLECTIONS

In your opinion, what was the most important obstacle that had to be overcome in the development of emergency medicine as a specialty board?

"The other boards."

RONALD KROME, MD
President of ABEM, 1984–1985
ABEM Director, 1976–1988