Comparison of primary and delayed wound closure of dog-bite wounds

Z. Xiaowei1,*, L. Wei2,*, H. Xiaowei3, X. Yunbei1, L. Zhenhua1, Y. Yeqing4, Y. Jiaqi1, W. Chuanlin4

1Urology Department, Peking University People’s Hospital, Beijing, China; 2Hepatobiliary Department, Peking University Cancer Hospital, Beijing, China; 3Cardiology, Beijing Anzhen Hospital, Capital Medical University, Beijing, China; 4Emergency Department, Peking University People’s Hospital, Beijing, China

Keywords
Dog bite, primary wound closure, delayed wound closure, wound infection, cosmetic scale

Summary
Background: Primary bite wound suturing in the emergency department remains controversial in some cases.
Objective: We conducted a study to investigate the infection rate and cosmetic appearance between primary wound closure and delayed wound closure in dog bite wounds in humans.
Methods: All patients with bite wounds were treated with oral antibiotic medications. We adopted a randomized cohort study, dividing the patients who needed wound closure into two groups: 60 patients for primary closure, and 60 patients for delayed closure, and compared the infection rate and wound cosmetic appearance scores.
Results: In the primary closure group, four people (6.7%) developed a wound infection without systemic infection. In the delayed closure group, three people (5%) developed a wound infection (p = 0.093), but there were not any patients that developed a systemic infection. Thirty-three patients (55%) in the primary closure group had optimal cosmetic scores, whereas 20 patients (33.3%) in the delayed closure group had optimal cosmetic scores (p = 0.012).
Conclusion: Although primary wound closure for dog bites may be associated with a higher infection rate, the cosmetic appearance after primary closure was still acceptable.

Patients and methods
We conducted a controlled study in selected dog bite wounds, aiming to investigate the infection rate and cosmetic appearance following primary and delayed wound closure. This study was conducted in the emergency department of the Peking University People’s Hospital, Beijing, China. This is a tertiary teaching hospital which treats approximately 5000 patients with animal-induced injuries annually. The local ethics committee approved this study.

Patients who presented between April 2010 and April 2011 with dog attack lacerations were prospectively entered into our wound registry. Bite victims who sought medical attention at the emergency department with one or more lacerations were included in the wound registry. Patients were excluded if they required plastic surgery or if they also had fractured bones, muscle and tendon damage, visceral injury, bites by confirmed rabid dogs, congenital or acquired immunodeficiency, an artificial blood vessel, joint implantation, or a delay in presentation of more than 24 hours after the bite (9). Taking into account the aesthetic issues, patients with head and neck bites were treated by plastic surgeons and therefore were not enrolled in our study.

The patients were treated initially by the following methods at the first presentation. Lacerations were copiously high-pressure irrigated with normal saline using a pulsatile wound lavage system6 to minimize infection. The irrigation pressure was applied with potential sequelae, including septic arthritis, osteomyelitis, endocarditis, and septic shock. The purpose of this study was to perform a controlled study of dog bite lacerations, to assess primary wound closure in the emergency department.

Introduction
Dog bite wounds are a common medical condition in people presenting to the accident and emergency department. Weiss and colleagues reported that up to 4.5 million Americans are bitten by animals each year (1). Bites account for five percent of the total traumatic wounds evaluated in the emergency department and approximately one percent of all emergency department visits (2, 3). China, the most populous country in the world, has numerous animal induced injuries each day. There is an estimate that nearly 14 million bites occur annually and that one in every seven patients, or two million bite victims, require medical attention. However, the treatment of dog bite wounds remains controversial. Compared with delayed wound closure, primary suture closure of facial bite wounds is more cosmetically acceptable and the findings of some recent studies support primary closure (4-8). However, an increased infection rate may be observed in primary wound closure; this is a worrisome complication with potential sequelae, including septic arthritis, osteomyelitis, endocarditis, and septic shock. The purpose of this study was to perform a controlled study of dog bite lacerations, to assess primary wound closure in the emergency department.

Keywords
Dog bite, primary wound closure, delayed wound closure, wound infection, cosmetic scale

Correspondence to:
Wang Chuanlin, M.D.
Emergency Department
Peking University People’s Hospital
Beijing, China 100044
People’s Republic of China
E-mail: erwangchuanlin@gmail.com

* These two authors contributed equally.
proximately 69 kPa (10 pounds per square inch) as recommended by the Agency for Health Care Policy and Research guidelines (10, 11). Necrotic and devitalized tissues were debrided completely. Amoxicillin with clavulanic acid (adult: 0.1g/BID; child: 1.5-3.0 mg/kg/BID) was administered orally for three days. Rabies immunoglobulin was infiltrated around the wound if needed (11). These patients were then again presented for post-exposure vaccine prophylaxis on days 0, 3, 7, 14 and 28 days (11).

At the initial presentation, the physician informed the subjects of the study aims, methods, and the potential benefits and hazards of the study. The informed consent document was signed by each subject. After the initial treatments were completed, we randomized participants, using sequentially numbered, opaque sealed envelopes into two groups of primary suture or delayed wound closure. For primary suture patients, the wounds were sutured in the emergency treatment room on the initial visit. For the delayed wound closure patients, the wounds were left open and the patients returned to hospital to have their dressing changed every day for three consecutive days and then had a delayed wound closure. The most commonly used suture method was simple interrupted suture, but this may have been adjusted according to different wound types. For both groups, if the wounds were found to have become infected after suturing, then the wounds were explored and treated in the emergency department operating room and intravenous antibiotic medication was administered. The follow-up was continued until the wound healed.

Wound infection was defined as the presence of a stitch abscess, distance from cellulitis margin to wound margin ≥1 cm, or purulent drainage (12-15). The physicians evaluated wound healing status and judged whether infection had occurred when the patients presented on the initial examination and at the time of suture removal. The clinical diagnosis of infection was made using a previously described grading scheme that has been shown to have excellent concordance (16). Meanwhile these physicians had completed the triage training programme, and had at least three years of experience in emergency. Their suture training consisted of pre-reading of articles on wound care, followed by two years of practical suturing in patients.

Clinical data for each subject were recorded on a standardized wound registry data collection instrument at the time of initial presentation and at the time of suture removal. Information recorded included patient demographics (age, sex 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 (irrigation and debridement), and wound closure techniques (use of deep sutures, type of closure, number and type of superficial sutures, use of systemic antibiotic medications, and type of wound dressing). These descriptive criteria of wounds have been shown to have excellent inter-practitioner concordance (kappa ranging from 0.52 to 0.89) when applied by physicians (12).

Wound cosmetic scale evaluation was conducted by a professional plastic surgeon (12). All sutures generally were removed after seven days when the patients returned for suture removal. Three months later, the patients returned to the hospital for evaluation of the laceration by a practitioner who was blinded to the patients previous treatment group assignment. The practitioner assigned 0 or 1 point each for the presence or absence of a step-off of borders, contour irregularities, margin separation, edge inversion, excessive distortion, and overall appearance. A total cosmetic score was calculated by adding the points for these six categories. As previously defined, a score of 6 was considered suboptimal and a score of less than 6 was considered suboptimal. According to the findings of a recent study, this scale has excellent concordance for total cosmetic score and corresponds to patient wound assessments (15). The cosmetic appearance of the wounds at three months correlates with the cosmetic appearance at one year, and also correlates with the patient’s assessment of the cosmetic result (17, 18).

The patients received written instructions upon discharge which included information on general wound care, daily wound inspection, instructions for observing infection and other complications, follow-up and compliance. Patients who failed to return to the emergency department for follow-up were considered to be excluded from the study.

Data were imported into a software programme 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. The 95% confidence interval was considered significant.

### Results

During the study period, 154 patients were treated for dog bites in the emergency

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**Table 1** Demographics of the primary suture and delayed suture groups (mean ± standard deviation; range).

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Age (years)</th>
<th>Sex (male/female)</th>
<th>Presentation time following bite (hours?)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary closure</td>
<td>60</td>
<td>28.1 ± 9.1</td>
<td>36/24</td>
<td>2.7 ± 1.3 (0.5 – 8.5)</td>
</tr>
<tr>
<td>Delayed closure</td>
<td>60</td>
<td>30.8 ± 8.8</td>
<td>32/28</td>
<td>2.3 ± 1.0 (0.6 – 3.1)</td>
</tr>
<tr>
<td>p</td>
<td>0.208</td>
<td>0.134</td>
<td>0.103</td>
<td></td>
</tr>
</tbody>
</table>

*p <0.05 has statistical significance.

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a Influx Medical Device Co., Ltd., Qingdao, Shandong, China

b C-amoxiclav: Xinya Pharmaceutical, Shanghai, China

c SPSS 11.5 for Windows: SPSS Science, Inc., Chicago, IL, USA
department. After the informed consent document had been signed, 120 of these patients were enrolled in our programme. No patients were lost to follow-up at the time of sutured removal; this was probably in part due to the short-term time period of this study. Furthermore, all patients returned to hospital for a second wound evaluation in the first six months after their suture removal, and only a few patients from both groups complained about the scars and wished to have a further consultation with a plastic surgeon.

The demographic characteristics of the patients enrolled in the study, and the time of presentation following the bite in the two groups were not significantly different (p >0.05) (Table 1).

In the primary suture group, the bite wound lacerations were located on the trunk (15%), upper extremity (45%), and lower extremity (40%). In the delayed wound closure group, the lacerations were located on the trunk (16.7%), upper extremity (40%), and lower extremity (43.3%). There were not any significant differences between the two groups in the length, width, or depth of the wounds. All of the wounds in both groups penetrated the dermis. Moreover the percentage of wounds that were contaminated or containing a foreign body in the two groups was similar (Table 2). In both of the groups, the lacerations were often irregular (69%). Not all of the patients were radiographed to search for foreign bodies, but some patients were radiographed if the physicians were highly suspicious that there were foreign bodies in the wound.

In all, of the 60 patients who underwent primary closure, four patients (6.7%) developed a wound infection without systemic infection; in the delayed closure group, wound infection developed in only three patients (5%), but there were no patients which developed a systemic infection.

### Table 2 Bite wound characteristics of the primary suture and delayed suture groups (mean ± standard deviation; range).

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Length (cm)</th>
<th>Width (mm)</th>
<th>Depth (mm)</th>
<th>Presence of contamination (%)</th>
<th>Foreign bodies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary closure</td>
<td>60</td>
<td>3.0 ± 0.6 (2.1 – 4.2)</td>
<td>4.2 ± 1.1 (1.5 – 6.7)</td>
<td>1.6 ± 0.7 (0.5 – 2.2)</td>
<td>26.7%</td>
<td>6.7%</td>
</tr>
<tr>
<td>Delayed closure</td>
<td>60</td>
<td>3.3 ± 1.0 (1.9 – 4.5)</td>
<td>4.8 ± 2.1 (1.5 – 7.0)</td>
<td>1.9 ± 0.9 (0.6 – 3.1)</td>
<td>28.3%</td>
<td>8%</td>
</tr>
<tr>
<td>p*</td>
<td>0.136</td>
<td>0.102</td>
<td>0.121</td>
<td>0.348</td>
<td>0.230</td>
<td></td>
</tr>
</tbody>
</table>

*p <0.05 has statistical significance.

### Table 3 Infection rates and cosmetic scores of the primary suture and delayed suture groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number patients</th>
<th>Number non-systemic infections (%)</th>
<th>Number with optimal cosmetic scores (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary closure</td>
<td>60</td>
<td>4 (6.7%)</td>
<td>33 (55.1%)</td>
</tr>
<tr>
<td>Delayed closure</td>
<td>60</td>
<td>3 (5%)</td>
<td>20 (33.3%)</td>
</tr>
<tr>
<td>p*</td>
<td>0.093</td>
<td>0.012</td>
<td></td>
</tr>
</tbody>
</table>

*p <0.05 had statistical significance.

### Table 4 Location and number of the infected bite wounds in the primary suture and delayed suture groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>Total</th>
<th>Palm</th>
<th>Forearm</th>
<th>Posterior tibial</th>
<th>Foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary closure</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Delayed closure</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

The proportion of patients who had an optimal cosmetic score was significantly higher in the primary closure group (31/60) than in the delayed closure group (17/60) (p = 0.012) (Table 3). In the suboptimal wounds, we found that the median cosmetic score from primary closure group (4.4; range: 2-5) was higher than the delayed wound closure group (3.9; range 1-5) (p <0.05).

### Discussion

The treatment of dog bite wounds remains controversial. In most areas of China, it is generally believed that dog bite wounds should be treated by a conservative procedure (19). The wounds usually are irrigated and debrided cautiously, and then a delayed wound closure is performed.

The severity of dog bite wounds may span from a simple scratch to more severe punctures, lacerations, and avulsion (20). All can result in significant damage, regardless of the amount of bleeding present. Larger dogs are able to deliver a bite force capable of perforating light sheet metal (21). Lacerations, or less commonly, puncture wounds and avulsions, may also occur (22). The bacteria in dog saliva include Staphylococcus aureus, streptococci, Pasteurella multocida, and anaerobes (3). Bite-wound contamination by such bacteria increase the risk of development of potential sequelae, including septic arthritis, osteomyelitis, endocarditis, and septic shock (5). Prospective clinical trials of dog bites suggest that persons treated with antibiotic medications may have lower infection rates, although this was not statistically significant. Amoxicillin with clavulanic acid was administered to bite-wound patients in this study because of its activity against many of the common dog-bite bacteria (3, 23). In patients presenting late with infected wounds, the intravenous route of administration is performed (3).

Dog bite wounds are often left open because of their reputation for infection if pri-
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Conclusions

Although primary suture closure of dog bite wounds is controversial, the results of our study found that the infection rate with primary suture closure was slightly higher than with delayed wound closure. Taking into account the patient’s wound aesthetic requirements, the infection rate associated with primary suture closure was still within an acceptable range.

Conflict of interest

None declared.

Funding

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References


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