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Primary closure versus non-closure of dog bite wounds. A randomised controlled trial

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ABSTRACT

Introduction: Dog bite wounds represent a major health problem. Despite their importance, their management and especially the role of primary closure remain controversial. In this randomised controlled trial, the outcome between primary suturing and non-closure was compared.
Methods: 168 consecutive patients with dog bite injuries were included in this study. The wounds were allocated randomly in two treatment approaches: Group 1, consisting of eighty-two patients, had their wound sutured, whilst Group 2, consisting of eighty-six patients, did not have their wounds sutured. All wounds were cleansed using high-pressure irrigation and povidone iodine. All patients received the same type of antibiotic treatment. Our measured outcomes included presence of infection and cosmetic appearance. Cosmetic outcome was evaluated using the Vancouver Scar Scale (VSS). Wound and patient characteristics, such as time of management, wound location and size, and patient age, were recorded and analysed for their potential role in the resulting outcome.
Results: The overall infection rate was 8.3%. No difference in the infection rate between primary suturing and non-suturing group was detected in the present study. The cosmetic appearance of the sutured wounds was significantly better (mean score 1.74) compared to the wounds that were left open (mean score 3.05) ($p = 0.0001$). The infection rate was comparable among all age groups. Wounds treated within 8 h of injury demonstrated an infection rate of 4.5%, which is lower compared to the 22.2% rate observed in wounds treated later than 8 h. The wounds located at the head and neck exhibited better results in both infection rate and cosmetic outcome. Additionally, wounds >3 cm negatively affected the cosmetic appearance of the outcome.
Conclusions: Primary suturing of wounds caused by dog bites resulted in similar infection rate compared to non-suturing. However, primary suturing exhibited improved cosmetic appearance. Time of management appeared to be critical, as early treatment resulted in lower infection rate and improved cosmetic appearance regardless suturing or not. Furthermore, wounds located at the head and face demonstrated better results.

Introduction

Dog bite wounds represent approximately 60–80% of all animal-related injuries [1,2]. Considering the fact that these injuries are responsible for approximately 1% of all emergency department visits and that they can be easily complicated, it is surprising that controversy still surrounds certain topics of their management [2–4]. For example, until recently, there were not well-defined criteria for antibiotic treatment for dog bite wounds management; their treatment was mainly empirical and, therefore, approximately 20% of these injuries was mismanaged [2,5].

Although the role of suturing in dog bite wounds is well discussed in the literature, several issues remain controversial [6]. Traditionally, it was suggested to leave these wounds open because of the proposed increased risk of wound infection when sutured [6–8]. However, there are reports indicating that suturing of animal wounds does not necessary increase the incidence of infection [9–11]. Unfortunately, most of these studies are outdated and performed in different settings; comparisons are thus difficult to make [9,10]. Additionally, most of the existing evidence focuses on the rate of infection, whilst other important measured

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outcomes, such as scar formation, are frequently overlooked or evaluated only in the case of facial wounds [4,12,13].

The controversy regarding the therapeutic management of dog bite wounds is increasing along with the discovery of new factors that can interfere with the outcome [13,14]. For instance, location of the wound seems to be a crucial factor. In particular, strong evidence supports suturing of face wounds versus hand wounds, although initially recommendations suggested leaving either wound unsutured [14–16]. Furthermore, the role of the size of the wound as well as the timing of suturing towards the final outcome has been erratically evaluated, with no consensus present in the literature [17].

The purpose of this study was to evaluate the role of primary suturing in the management of dog bite injuries in comparison to the traditional non-suturing approach. Additional factors that could interfere with the final outcome were assessed. The institutional review board has approved this study and all patients gave their informed consent.

Patients and methods

From 2009 to 2012, 200 consecutive patients with a dog bite injuries were included in the present study. A power analysis determined that a sample of 124 patients would be adequate to demonstrate significance for cosmetic appearance. The aim was to detect with 95% power at 0.05 level of significance a difference of 1.30 between the groups. This difference was based on the findings of a pilot study that also determined a standard deviation (SD) of 1.42 and 2.34 for each group respectively. To ensure that the number of patients analysed after exclusion and lost to follow up would be adequate, two hundred patients were evaluated. The inclusion criteria were: (a) the presence of a dog bite wound that penetrated the epidermis and/or dermis (full thickness wounds); (b) presentation to the emergency department within the first 48 h post-injury; and (c) patient age of 16 years and older. Exclusion criteria were the presence of a complex or a complicated wound (i.e., presence of a fracture, muscle injury, etc.). Patients with any kind of compromised immune system or allergic reaction to the antibiotics were also excluded. All patients were allocated randomly into two different treatment approaches (primary suturing versus non-suturing) via a computer-based system. The orthopaedic surgeon who evaluated the patient initially, determined whether if he/she would be eligible for the study. Subsequently, after the patient gave the informed consent to participate in the study the allocation was determined based on the computer program operated by another clinician. Therefore, the surgeon entering the patient in the study did not know the randomised allocation.

All wounds initially received irrigation under high pressure with a needle and 50 ml syringe with normal saline solution up to a total volume of 500 ml [18]. Subsequently, local scrubbing with the use of povidone-iodine (Betadine 10% solution) was used for wound cleansing. Surgical debridement was performed in all cases as needed, with meticulous care to remove all tissues with compromised viability but with extreme care, so that dermal wounds would not be converted into full thickness injuries if possible. In the first group, the wound was left opened, whilst the wound was sutured with the use of Ethilon 3-0 or 4-0 nylon sutures (depending on the location of the wound) in the second group. Before suturing, anaesthesia was provided by lidocaine 2% (20 mg/ml). Simple interrupted sutures were used in all cases; suturing resulted in approximation of the skin traumatic edges. Amoxicillin/clavulanic acid, 500/125 mg (Augmentin, GlaxoSmithKline plc, London, UK) were given every 12 h for 5 days in all patients. Tetanus toxoid was administered together with immunisation when indicated. Further, the same dressing of dry gauze was used in both groups, and all patients were advised to keep the wound dry for 48 h. No immobilisation was recommended in any patient. Dressing changing and follow up was conducted every 2 days until day 10, and weekly thereafter until the third month from injury.

Table 1
Major and minor criteria used for diagnosis wound infection [5].

Major criteria (*one* required for diagnosis)	Minor criteria (*four* required for diagnosis)
(1) Fever ($\theta > 38\,^{\circ}C$)	(1) Local erythema that extended more than 2 cm from the edges of the wound
(2) Local abscess	(2) Tenderness at the wound
(3) Lymphangitis	(3) Oedema at the site
	(4) Purulent drainage
	(5) WBC > 12,000

θ, temperature; WBC, white blood cell count per cubic millimetre.

Suture removal was performed at day 7 for wounds located at the head, face, and neck, at day 10 for wounds in upper extremities, and at day 14 for wounds located at lower extremities and trunk. During follow up, two major outcome measures were evaluated: infection rate and cosmetic outcome. The presence of infection was assessed using definitive and relative criteria. Definitive criteria for infection considered the presence of systematic fever, local abscess, or lymphangitis. Relative criteria included erythema at the edges of the wound, local swelling, increased temperature or tenderness, as well as drainage from the wound (Table 1). Recording of the cosmetic appearance of the wound was conducted at the end of the fourth week following initial injury with the use of the Vancouver Scar Scale (VSS) [19–21]. A surgeon blinded to the treatment performed the evaluation. The effect of other parameters, such as (a) timing of suturing in the final outcome, (b) location of the wound, (c) age of the patient, and (d) size of the wound, was also evaluated.

Statistical analysis was performed using SPSS 16.0 (Chicago, IL, USA). A Fisher's exact test was used for the analysis of the nominal variables and an ANOVA test was applied for data comparison. A two-tailed p value was always calculated, with statistical significance considered present when $p < 0.05$.

Results

During assessment, 18 patients were excluded from our analysis and 14 patients were lost in the follow up (Fig. 1), leaving 168 patients to be included in our analysis. Eighty-two patients had their wounds sutured (group 1) and in eighty-six patients, the

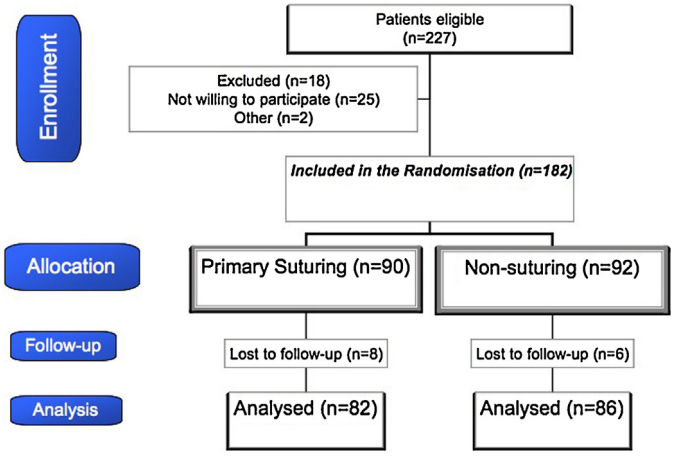

Fig. 1. Screening Randomisation and follow up of the participants of the study.

Table 2
Characteristics of the wounds in the two groups.

	Primary suturing	Non-suturing	*p*-Value
Topography			
Head/neck	20	21	
Hand/arm	40	43	0.71
Lower limp	16	17	
Trunk	6	5	
Mean age (years), (SD)	44.3 (19.4)	43.9 (19.1)	0.89
Gender (♂/♀)	54/28	56/30	1.0
Mean wound size (cm) (SD)	2.17 (0.77)	2.12 (0.78)	0.82
Total	82 patients	86 patients	
Infection rate (No. of patients), (%)	8 (9.7%)	6 (6.9%)	0.51
Cosmetic appearance (mean), (SD)	1.74 (1.8)	3.05 (3.1)	0.0001
Treatment time (<8 h/>8 h)	65/17	67/19	0.85
Infection (<8 h/>8 h)	3/4	3/4	

wounds were left open (group 2). The topography of the wounds, as well as the different characteristics in the two groups, are shown in Table 2.

The infection rate in our study was 8.3% (Table 3). Eight patients belonging to the primary suturing group developed infection, whilst 6 patients of the non-suturing group showed signs of infection ($p = 0.51$) (odds ratio 1.44, 95% CI 0.48–4.35). Patients having infected wounds were admitted to the hospital and IV antibiotics were given based on culture results. Surgical debridement and irrigation was also used to supplement the treatment. In all cases, the infection subsided and patients were discharged within 10 days of admittance.

Regarding the cosmetic outcome of the different treatment groups, primary suturing exhibited significantly better results with a mean score of 1.74 for the modified VSS. In the non-suturing group, a mean score of 3.05 for the VSS was recorded ($p = 0.0001$). Head and neck wounds exhibited an improved cosmetic outcome compared to the wounds located elsewhere on the body. This difference can be attributed partially to the absence of infection in this location. In order to test the above hypothesis, an additional analysis of the non-infected and infected wounds regarding the cosmetic appearance and location was performed (Table 4). Results found the non-infected wounds to have an improved cosmetic appearance compared to the infected wounds regardless of their location. Remarkably, the cosmetic appearance of the non-infected wounds located at the head was better than that of the wounds on other locations of the body.

In assessing the effect of timing, 132 patients were treated within 8 h of the injury, whilst 36 patients sought medical attention 8 h post the time of the injury. Within the time factor, early (<8 h) management demonstrated favoured outcomes, with only 6 patients (4.5%) developing signs of infection. On the contrary, of the 36 patients presenting in the emergency department 8 h after the injury, 8 of them developed signs of infection (22.2%) ($p = 0.0025$) (odds ratio 0.17, 95% CI 0.05–0.51).

Whilst none of the bites located at the head and face exhibited signs of infection, a significantly higher incidence of infection was demonstrated when comparing head wounds with those located at the upper extremities (10.8%) ($p = 0.03$). Further, the incidence of infection was found to be similar between the different age groups, as shown in Table 3. Although the size of the wound was related to the cosmetic outcome, with larger wounds (>3 cm) demonstrating poor cosmetic appearance ($p = 0.01$), wound size was not correlated with the infection rate (Table 5).

Table 3
Infection rate in relation to age/time and suturing/time.

	Infection in <8 h	Infection in >8 h	Infection total (%)
Young adults (16–39)	3/63 (4.7%)	3/18 (16.7%)	6/81 (7.4%)
Middle age adults (40–65)	2/45 (4.4%)	3/10 (30.0%)	5/55 (9.1%)
Senior adults (>65)	1/24 (4.2%)	2/8 (25.0%)	3/32 (9.3%)
Total	6/132 (4.5%)	8/36 (22.2%)	14/168 (8.3%)
Primary suturing	4/65 (6.1%)	4/17 (23.5%)	8/82 (9.7%)
Non-suturing	2/67 (2.9%)	4/19 (21.0%)	6/86 (6.9%)
	$p = 0.43$	$p = 1.0$	$p = 0.51$
Total	6/132 (4.5%)	8/36 (22.2%)	$p = 0.0025$

Table 4
Site and cosmetic appearance in infected and non-infected wounds.

	Infected (VSS)	Non-infected (VSS)	Total
Head neck: No. of patients (mean)	0 (–)	41 (0.85)	41
Upper limb: No. of patients (mean)	10 (3.14)	73 (2.87)	83
Lower limb: No. of patients (mean)	3 (3)	30 (2.88)	33
Trunk: No. of patients (mean)	1 (3)	10 (2.9)	11
Cosmetic score, mean (SD)	3.07 (0.77)	2.37 (2.76)	168

Discussion

The present study compared primary suturing of dog bite wounds with non-suturing in a randomised controlled trial. There is currently no consensus in the literature regarding the need for primary suturing in animal related wounds. Traditionally, most studies suggest primary suturing of a wound only when it is located to the head and face, whilst all other wounds are suggested to be left open [4,7,8,14]. To our knowledge, there is only one prospective randomised trial that has evaluated primary closure in dog bite wounds [22]. This past study found no increased risk of infection because of primary suturing of the wounds, confirming similar reports in the literature [11,13]. In the present randomised controlled trial, there was also no higher incidence of infection associated with primary closure, with a significantly improved cosmetic appearance of the sutured wounds.

The findings of the current study confirm the contribution of the time of management to the final outcome. Early management of the bite wounds seems to be correlated with lower infection rates and improved cosmetic outcomes regardless of the closure or not of the wound. The role of timing in the infection rate for non-bite related traumatic wounds has recently gained more attention [17,23]. However, it is not clear whether primary closure can reverse the recognised tendency of older wounds for infection, nor the exact time period within which the wounds can be safely closed [17,23,24]. In dog bite wounds, the potential for infection is increased compared to non-bite related wounds, possibly due to the mixed bacterial population [5]. Results suggest that time is an important factor in the development of infection, and early management in bite wounds can offer significant advantages to the overall outcome.

High-pressure irrigation, surgical debridement, and antibiotics were used as a routine in all of our patients. Dog bite injuries cause a crushing injury to the tissues, implying that there are tissues with

Table 5
Correlation of wound size with infection rate and cosmetic appearance.

	Size <3 cm	Size >3 cm	*p*-Value
Infection	7/95	7/73	0.78
Cosmetic appearance, mean (SD)	1.98 (2.06)	2.97 (3.22)	0.01

compromised viability due to the impact associated with this type of injury. The beneficial role of surgical debridement in these cases has been highlighted early [25]. This is the reason that surgical debridement was performed in both groups in this study. Although the use of antibiotics has been debated in the past, they seem to offer some protection against infection [5,10,26,27]. The trauma management in the present study also included high-pressure irrigation of the wound, as it has proven to act as a bacterial decontamination technique [18].

The considerable role that wound location plays in the rate of infection is already known [13,22,23,27]. Wounds at the head and face have significantly lower rates of infection [6,10,13]. The impact of the cosmetic appearance in patient satisfaction is the reason why head and face wounds are considered a good candidate for primary closure; thus far, suturing of these bite wounds have shown promising results. Wounds located in the head and face exhibited not only lower infection rates, but also exhibited better cosmetic outcomes regardless of infection. This suggests that the increased vascularisation in the head and neck compared to the rest of the body plays a significant role towards the enhanced outcomes in both infection rate and cosmetic appearance.

The present study contains certain limitations. Despite the fact that there was not a significant difference between the sutured and non-sutured wounds, this result might be misleading due to the fact that this study is not adequately powered to detect moderate differences in the infection rates. Also, a specific type of wounds was included in the study: only skin wounds that did not involve injury to deeper structures such as muscle or bone were included. Further, patients were only included if they sought care within 48 h of the injury. More complicated wounds, such as full-thickness wounds, have increased morbidity and can result in serious complications requiring hospital admission [8,15,28]. In such wounds, a different treatment approach is necessary. One issue that often appears in similar studies is the relatively small number of patients included, resulting in insufficient power to identify significance. For this reason, this study conducted a power analysis to determine the number of patients needed to show a significant effect. However, it is quite unsafe to recommend suturing for all dog bite wounds, before larger randomised trials or meta-analyses would be able to provide stronger evidence towards one approach. Furthermore, it is very important to realise that the findings of the present study cannot be applied in all wounds inflicted by dogs, but only in those meeting the inclusion criteria. Thus, it is crucial that criteria be carefully studied and outlined for which types of wounds can be best served by particular techniques in order to optimise outcomes on a case-by-case basis.

Conclusions

Primary suturing of dog bite wounds when associated with debridement, high pressure irrigation, povidine iodine cleansing and antibiotic administration resulted in improved cosmetic appearance with no significant increase in the rate of infection. A non-suturing approach was found to be less successful in regards to scar formation. According to this study, one of the most important factors contributing to the outcome was the timing of the management, with early treatment (<8 h) resulting in lower infection rates and improved cosmetic appearance. Wound location also was found to affect the final outcome, with wounds at the head and face demonstrating overall better results.

Conflict of interest statement

The authors declare no conflict of interest in the preparation and presentation of this article.

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