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Title Page

Dog Bite Injuries in the Pre-hospital Setting: Can the old dog be taught new tricks?

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Key Points

- Whilst the majority of dog bite injuries are generally low acuity, they have the potential to attract a disproportionately high number of malpractice claims due to mismanagement.
- In an increasingly litigious society, empirical approaches to the management of dog bite injuries may render practitioners particularly vulnerable to litigation.
- The rate of infection associated with dog bites to the hand and wrist is significantly higher than bites to other anatomical locations.
- Irrigation is considered key to the prevention of infectious complications, provided volumes and pressures are adequate.
- Antibiotic prophylaxis is recommended for all dog bite injuries.

Abstract

Dog bite injuries are a common cause of patient presentation to NHS emergency departments (EDs) and minor injuries units, and are generally associated with a low level of acuity, despite an inherent capacity for significant soft tissue damage to be inflicted by canine jaws capable of exerting terrific bite forces. Anatomical sites for injury correlate to victim age, with hand and wrist injuries predominating in the adult population. The most common complication is infection secondary to inoculation of oral flora, with the hands being particularly vulnerable due to their anatomy. Injuries to structures such as tendons can be discreet, and retained foreign bodies can easily be overlooked. Wound care has a propensity to attract a disproportionately high level of malpractice actions, and approaches to the management of dog bite injuries have largely been empirical, which may render the practitioner particularly exposed. In response to increasing pressures on healthcare systems, paramedics with extended scopes of practice, including wound care and suturing, are being utilised to assess, manage, treat, and either refer or discharge patients with apparently minor injuries, in strategies aimed at reducing hospital admissions. This article adopts a case study format to examine and evaluate treatment modalities and the current evidence base informing best practice in terms of dog bite injuries from the perspective of a paramedic practitioner, with critical reflection on the decision making process and complexities of such episodes of care in the pre-hospital setting.

Key words

Dog bite, wound, laceration, infection, pre-hospital.

Introduction

Dog bite injuries are a common cause of patient presentation to emergency departments (EDs) and minor injuries units in the United Kingdom (UK). Data indicates that during 2015-16 there were 7673 finished admission episodes (FAEs) attracting an external cause code of dog bite or strike (NHS Digital, 2017). Whilst annual admission figures appear to be rising, presenting a serious clinical problem, it is estimated that only 10% to 50% of all dog bite injuries are ever reported (Pfortmueller et al, 2013). The financial burden associated with dog-related incidents is not inconsiderable, with an estimated cost to the NHS of around £10 million per annum (Mannion et al, 2015).

A dog bite offers potential for significant soft tissue damage, and the severity of injury has a direct correlation to the size and breed of the animal involved. Particular canine breeds are reported to be capable of exerting a bite force of 31790kPa, sufficient to crush bone and pierce sheet steel (Thomas and Banks, 1990; Kennedy et al, 2015). The extent of tissue damage inflicted may extend from simple abrasions, lacerations and puncture wounds, to significant avulsions, fractures, amputations, and neurovascular injuries with the potential for injuries to be both limb and life threatening. The anatomical site of injury tends to be

dictated by the age of the victim, with the hand and wrist the most frequently affected location in adults, and the head, face and neck in children (Rempe et al, 2009; Pfortmueller et al, 2013; Mannion et al, 2015).

Whilst the majority of dog bite injuries are generally low acuity, they are attracting increasing numbers of malpractice claims due to alleged mismanagement through inappropriate decisions regarding antibiotic prophylaxis and wound closure. It is intimated that this position exists as a result of approaches to dog bite management being based upon evidence which is essentially empirical (Morgan and Palmer, 2007). Recently, increased emphasis has been placed upon ambulance services to improve patient experiences by coordinating and delivering an array of services at scene, or in the home, in order to avoid hospital admission (Association of Ambulance Chief Executives, 2011). The introduction of paramedics with an extended scope of practice to assess, manage, treat, and either refer or discharge patients with apparently minor injuries, including wounds, in the community, has been one strategy aimed at reducing hospital admissions. In an increasingly litigious society where expectations appertaining to healthcare outcomes are high, the potential complexities of apparently low acuity bite injuries may render the paramedic practitioner particularly vulnerable to plaintiff actions.

A case study format has been adopted to allow examination and evaluation of treatment modalities and the current evidence base informing best practice. This will also provide a platform upon which to demonstrate the application of knowledge and to critically reflect upon the decision making process made by a paramedic practitioner in the pre-hospital setting.

The case

A 40-year-old male, received an isolated bite wound from a feral dog to his right hand whilst attempting to protect his own animal from attack. Half of all dog bite injuries to the hand are sustained in the process of separating fighting dogs (Nygaard and Dahlin, 2011). A right hand dominant, self-employed electrician, he reported no significant prior medical or surgical history, and took no medications. He was a smoker – 22 pack years, and consumed 20 units of alcohol per week. The presence of any allergies or sensitivities was excluded but his tetanus immunisation status could not be established. No significant delay had occurred in seeking care, with an ambulance having been called 10-15 minutes post incident. Delay in seeking attention and treatment is shown to significantly increase the likelihood of infection and the need for surgical intervention (Maimaris and Quinton, 1988; Jha et al, 2014). Risk factors which would adversely affect the patient's ability to heal normally, such as chronic disease states including diabetes, liver cirrhosis, renal failure, chronic obstructive pulmonary disease, anaemia, and peripheral vascular disease were excluded. Haemodynamically, the patient was stable, and initial examination revealed a 0.8cm diameter puncture to the dorsum of the right hand, approximately 1cm proximal to the fifth metacarpophalangeal (MCP) joint, and a 3.5cm longitudinal laceration proximal to the distal palmar crease over

the hypothenar eminence, parallel to the ulnar edge. Ownership of the attacking dog, the breed, and health status of the animal could not be established. A thorough history is essential in not only identifying factors which may predispose the patient to developing secondary infectious complications but also from a medicolegal perspective with the potential for subsequent prosecutions of dog owners (Morgan and Palmer, 2007; Nicks et al, 2010; Kennedy et al, 2015)

Wound management aims

The primary aims of wound management are detailed examination, optimal cleansing, efficient closure, prevention of secondary infectious complications, and the minimisation of residual scarring (Nicks et al, 2010). Both metabolic and physiological factors affect healing and can produce poor outcomes if those conditions under which reparation occurs are not optimal, potentially rendering an acute wound chronic. In addition to chronic disease states, also implicated in delayed healing is the use of non-steroidal anti-inflammatories (NSAIDs), anticoagulants, corticosteroids and chemotherapeutic agents (Garcia-Gubern et al, 2010). Whilst none of the foregoing featured, smoking would predispose the patient to increased risk of poor outcome, and this is discussed later.

Bites to the hand

The most common complication of a dog bite injury is infection from the deep inoculation of oral flora, with *Pasteurella*, *Streptococcus*, *Staphylococcus*, *Moraxella*, *Neisseria*, and *Bacteroides* common isolates in a predominantly polymicrobial setting (*Table 1*) (Talan et al, 1999; Kennedy et al, 2015). The rate of infection associated with dog bites is analogous to non-bite lacerations, ranging from 1.4% to 30% (Rempe et al, 2009). This comparatively low infection rate increases with bites to the hand (28% to 47%), where the anatomy, which comprises multiple compartments, and scant presence of soft tissue between skin and bone, lends to potential bacterial infiltration and propagation via structures such as tendons, ligaments and bones (Morgan and Palmer, 2007; Kennedy et al, 2015). It is suggested that 62% of wounds overlying metacarpophalangeal or proximal interphalangeal joints demonstrate penetration of the joint space below (Jha et al, 2014). Complications can include cellulitis, abscess, septic arthritis, osteomyelitis, tenosynovitis, and severe sepsis.

Examination and assessment

Physical examination of acute wounds necessitates the assessment of wound location, size and depth, devitalised tissue, neurovascular status, joint integrity, and should attempt to exclude the presence of retained foreign bodies and infection (Nicks et al, 2010; Kennedy et al, 2015). Good lighting and a blood free field are essential to mitigate the risk of missing a retained foreign body and any damage to underlying structures (Garcia-Gubern et al, 2010). Most recipients of a dog bite will have attempted some degree of self-treatment immediately post incident, although this was limited to the application of a towel as a

dressing over the hand. The patient was encouraged to wash around the wounds with soap, and running warm water, the rationale being to remove surface contaminants, including any residual oral flora of the dog (Dendle and Looke, 2009). Optimal wound healing requires a body surface temperature of 33°C, below this temperature or above 42°C, healing is delayed. Wound cleansing using solutions at ambient temperature can cause a 2°C drop in wound bed temperature and cessation of cellular activity for 3 hours (Gannon, 2007). Therefore, warmed cleansing solutions appear essential, although these are not always readily accessible or measurable pre-hospital.

Capellan and Hollander (2003) advocate commencing examination with a neurovascular assessment to mitigate any risk of missing underlying injuries. The wounds had the potential to involve a number of structures including flexor and extensor tendons, bones, and branches of the ulnar nerve. A 'look, feel, move' approach was adopted, sequentially palpating the carpal and metacarpal bones, testing the range of movement of all fingers and the thumb at all joints both passively and against resistance, and pulp testing for sensation. A slight increase in pain was reported on flexion/extension of the fifth phalanx but the patient declined the offer of analgesia.

Irrigation

Irrigation is considered key to the prevention of infectious complications post wound closure through the removal of debris, dead tissue, retained foreign bodies, and micro-organisms, provided that the irrigation solution volumes and pressures are adequate (Rempe et al, 2009; Nicks et al, 2010). The solution used was 200ml sodium chloride 0.9%, delivered with a 20ml syringe and 18-gauge needle attached. The literature appears to support high pressure irrigation, with the use of a needle and syringe considered sufficient to generate pressures beyond which the adhesive properties of bacteria are believed to be overcome. However, there appears to be an absence of consensus appertaining to the optimal delivery pressure and method of delivery, with too low a pressure exerting negligible effect on particulate matter, and sustained high pressure liable to exacerbate tissue damage, increasing the risk of infection and poor healing (Garcia-Gubern et al, 2010; Nicks et al, 2010). Essentially, further research is required to ascertain the optimal pressure for irrigation and to identify the most suitable method of delivering a measured volume of cleansing solution to the tissue bed. The foremost aspect in reducing bacterial count within a wound is established to be the volume of irrigation, although there is an absence of consensus appertaining to the optimal volume, with recommendations ranging from a prescriptive 50 to 100ml per cm to simply copious amounts (Garcia-Gubern et al, 2010; Nicks et al, 2010; Paschos et al, 2014). While normal saline is the preferred cleansing solution, Fernandez and Griffiths (2012) in a Cochrane review found no significant difference in infection rates between tap water and normal saline. Anti-septic solutions such as chlorhexidine and povidone-iodine are understood to offer no advantage over normal saline, and may even damage tissue due to their cytotoxic action (Nicks et al, 2010; Garcia-

Gubern et al, 2010). Evidentially, normal saline remains the first-line option, ideally warmed prior to delivery, although tap water is acceptable, and is often used pre-hospital.

Exploration

The 0.8cm diameter puncture to the dorsum of the hand, 1cm proximal to the fifth MCP joint, presented immediate problems. The depth of a puncture wound, relative to width, can be deceptive and confident exploration was considered almost impossible. Slight swelling and 1-2mm of erythema was evident around the puncture. Effective irrigation with visualisation of the tissue bed was not possible, and is considered controversial due to the potential for infiltration in the absence of effective drainage (Capellan and Hollander, 2003). Injury to underlying bone and/or tendon could not be excluded, nor the possibility of a retained foreign body. The 3.5cm longitudinal laceration over the hypothenar eminence was approximately 0.3-0.4cm in width, with ragged margins. Confident visualisation of the wound bed and determination of the depth of the wound was not possible, although the presence of visible fat indicated penetration to the hypodermis. Foreign body contamination could not be excluded. Radiographs would be necessary, warranting onward referral of the patient (Capellan and Hollander, 2003; Garcia-Gubern et al, 2010).

Wound closure

The closure of dog bite wounds is the subject of much discourse in the literature, and remains controversial. Stefanopoulos et al (2004) discourage primary closure of bites to the hand due to the increased risk of infection, preferring delayed repair. Philipsen et al (2006), while acknowledging that the traditional approach to bite wound management advocates allowing wounds to heal by secondary intention, due to a perceived increased risk of infection, submit that meticulous evaluation should allow primary closure irrespective of anatomic location. Paschos et al (2014), in a randomised controlled trial (RCT), found no increased risk of infection with primary suturing of dog bite wounds when carried out in association with debridement and cleansing, high pressure irrigation, and antibiotic administration, mirroring the results of Maimaris and Quinton (1988) which they identify as the only other RCT evaluating primary closure of dog bite wounds. The decision on primary closure versus non-primary closure was not one which needed to be made pre-hospital as referral was already necessitated. From a perspective of the paramedic practitioner, it would appear further RCTs and meta-analyses are required in order to provide essential guidelines on closure versus non-closure to ensure optimal outcome for patients.

Antibiotic prophylaxis and tetanus toxoid

The nature of the wounds and their location predisposed the patient to increased risk of secondary infection. Medeiros and Saconato (2001), in a review of eight RCTs, were able to demonstrate that hand bites were an independent risk factor in infection and that the administration of prophylactic antibiotics confined incidences of secondary infection to 2%.

NHS guidelines currently recommend amoxicillin-clavulanate (co-amoxiclav) for 7 days as a first line prophylactic treatment in animal bites to the hand, face, and foot, puncture wounds, and wounds involving joints, tendons, ligaments and potential underlying fractures (NICE, 2015). Although not common to dog bites, wounds containing saliva, devitalised tissue and dirt are at risk from clostridium tetani (Richardson, 2006; Kennedy et al, 2015). Tetanus toxoid is recommended for those individuals whose primary immunisation is incomplete or where boosters are either not up-to-date or are up-to-date but the next booster is due. Tetanus immunoglobulin should be considered for administration for tetanus-prone wounds which would include punctures, open fractures, devitalised tissue, and retained foreign bodies. The patient's immunisation status was not clear at the time. Exemptions within current medical legislation allow registered paramedics to supply and administer a range of medicines, and under Patient Group Direction (PGD), they are able to supply and/or administer certain licensed medicines in specifically identified situations approved by their employing organisation, where the PGD is signed by a doctor and pharmacist. Paramedics with an extended scope of practice already supply and administer a limited number of antibiotics under PGD but there is considerable variation between organisations, and PGDs can be considered frustratingly proscriptive. While the patient was to be referred for other reasons, the necessity for antibiotic prophylaxis could not have been addressed by those PGDs available to the paramedic practitioner at the time.

Analgesia

Guo and Dipietro (2010) argue few data exist to suggest short-term use of non-steroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen has negative implications for wound healing. However, a number of papers have demonstrated that ibuprofen exhibits anti-proliferative effects which impact on fibroblast numbers, reduce contraction, delay re-epithelialisation, impair angiogenesis, and weaken the tensile strength of wounds (Dvivedi et al, 1997; Krischak et al, 2007; Williams, 2012). Inflammation is integral to healing, and Richardson (2004) argues that this process should not be subdued by anti-inflammatory drugs. Judicious use of NSAIDs and withholding the same in the immediate post injury phase, when the inflammatory process peaks, appears a sensible approach with paracetamol the first line analgesic choice (Stovitz and Johnson, 2003; Erpek et al, 2006). Ultimately, the patient elected to decline any analgesia.

Dressing application

A moist wound healing environment is central to cellular hydration, phagocytosis, growth factors, angiogenesis, re-epithelialisation, reduced pain and improved cosmetic outcomes (Fonder et al, 2007; Nicks et al, 2010). A low-adherence, ethylene-methyl acrylate sleeve with viscose absorbent core, indicated for clean/light to moderately exuding superficial wounds was applied. As the patient was to be referred, and the dressing would only be a temporary protective barrier pending further assessment, this was acceptable, although enhanced options would be needed to support increased community based treatment. A

slings provided elevation and immobilisation, a significant intervention in bite wounds to limbs during the first 48-72 hours, helping to reduce oedema and the risk of infection (Mor and Waisman, 2008; Rempe et al, 2009; Dendle and Looke, 2009).

Opportunity for health education advice

The patient was counselled on the benefits of smoking cessation to general health and wound healing. Substances present in cigarette smoking such as nicotine, tar, nitric oxide, hydrogen cyanide, and carbon monoxide have a deleterious effect on an individual's capacity to heal, altering the reparatory environment through anoxia, hypoxia, vasoconstriction and systemic toxicity. Nicotine particularly, encourages smooth muscle vasoconstriction, through thromboxane A² production and the reduced availability of prostacyclin caused by the stimulation of adrenaline. Nicotine also impairs erythrocyte and fibroblast proliferation, and increases platelet adhesion, resulting in increased risk of ischaemia, thrombus formation, infection and impaired manufacture of granulating tissue (Sorensen et al, 2003; Rayner, 2006).

Documentation and referral

Sufficient justification existed for patient referral, and such was the nature of the anticipated investigations/interventions, that effectively the ED presented as the most appropriate destination over any alternate pathways. Excellent documentation and emphasis upon inspection of the wound having been carried out in a blood free field with adequate lighting, supplemented by photographic images of the wound is considered to offer the practitioner the best defence against potential subsequent litigation actions, and may be required for other medicolegal purposes (Garcia-Gubern et al, 2010; Jha et al, 2014).

Conclusion

Although the majority of dog bite wounds generally attract a minor injury classification, this belays the complexities associated with their management and a significant potential for mismanagement with associated inherent risk of potential litigation. As the foregoing demonstrates, to mitigate risks to the patient and practitioner, rigorous investigations and interventions are required which perhaps remove all but the most trivial of injuries from the scope of current paramedic practice.

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Aerobic Species	Anaerobic Species
Pasteurella	Fusobacterium
Streptococcus	Bacteroides
Staphylococcus	Porphyromonas
Neisseria	Prevotella
Corynebacterium	Propionibacterium
Moroxella	Peptostreptococcus
Enterococcus	Eubacterium
Bacillus	
Klebsiella	
Capnocytophaga	

Table 1. Aerobic and anaerobic bacteria commonly isolated from dog bite Injuries (Talan et al, 1999; Kennedy et al, 2015)