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Bite Injuries to the Hand: Microbiology, Virology and Management

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Abstract: Bites to the human hand, be it from a pet, a stray animal or even a fellow human, may often have dire consequences for the person suffering the insult. Bites by mammals are a common problem and they account for up to 1% of all visits to hospital emergency rooms, in the UK. Clenched fist injuries to the mouth ('fight bite') are notorious for being the worst human bites. Bite injuries of the hand and their related infections must be monitored vigilantly and managed proactively, by experts in this field of surgery. In this review article we discuss the associated microbiology and virology of these injuries as well as their management.

Keywords: Animal bite, bite, fight-bite, hand, human bite, microbiology, virology.

INTRODUCTION

Bites to the human hand, be it from a pet, a stray animal or even a fellow human, may often have dire consequences for the person suffering the insult. Anatomically, the hand is a complex structure that enables us to perform fine, epicretic tasks. This sets us apart from the simian species that with a lack of opposition of the thumb have a much less sophisticated 'grasper' to interact with their surroundings.

The spectrum of complications stemming from a mismanaged infected bite to the hand ranges from cellulitis of the injured area to amputation of the affected part of the hand, with obvious socio-economic implications for victims and their dependants.

Hand trauma, is mainly found in the male sex, affecting the younger population and in the majority of cases is related to work, or assault injuries [1-3]. Data revealed in 2007 by The British Society for Surgery of the Hand [4] showed that 20% of patients attending the emergency room suffered from hand injuries, resulting in more than 1.36 million attendances for hand injuries in the United Kingdom each year. One in five of these injuries (271,000) required specialist care, and 71,000 patients required surgical intervention [5, 6].

Almost 1% of all visits to hospital emergency rooms in the United Kingdom are due to animal bites, with dog and cat bites being the most common. People are usually bitten by their own pets or by an animal known to them, with school-age children amounting to nearly 50% of those bitten [7]. It is worth noting that cat bites are more likely to lead to infection of the bitten hand when compared to dog bites [8]. In the USA, approximately 1 to 2 million Americans suffer from cat and dog bites each year [9], it is estimated that half of the American population will be bitten by an animal or another human being during their lifetime [10]. Snake and Spider bites amount to a large number of hospital attendances in rural areas and more exotic parts of the world [11, 12].

Closed fist punches to the human mouth ('fight bites') are notorious for being associated with the worst bite-related infections [13]. They are often underestimated and treated as 'minor injuries' without the health practitioner realising that the extensor tendon, the joint capsule and/or the deeper connective tissues may have been inoculated with oral bacteria [13, 14]. Due to the limited soft tissue envelope that covers the deeper structures and the numerous tight compartments, bite wounds to the hand have a higher infection rate, when compared to bites to other parts of the human body [15]. Unusual microbiological contamination often complicates human and animal bites, as these are often associated with plant, water and soil exposures [14]. Therefore, due to the great variety of bite wound sources and the complex polymicrobial organisms implicated, they deserve special attention [16-18]. Transmission of viruses are less common, especially after human bites, but hepatitis B and C, HIV, syphilis, HSV and HTLV-1 have been documented [19-25].

Delayed medical attention related to initial management of washout can result in varying degrees of cellulitis and local inflammation on presentation, which is more prolific in the immuno-compromised patient including diabetics and smokers [26, 27]. Morbidity related to bites is normally related to infectious complications. Antibiotics should be used as an adjunct to thorough washout as opposed to an alternative [7], but there is no set consensus on their use in these injuries. If the wound is not infected on presentation, wound cultures are not indicated as they do not predict infection or the responsible pathogen, but prophylactic

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antibiotics are considered normal practice where any suspicion of future infection is thought [28, 29]. Zubowicz [29] showed a 47% infection rate in patients treated with placebo versus 0% in antibiotic prophylaxis patients, although similar studies in lower risk patients (not breaching dermis or in extremities) have shown no greater benefit in antibiotic prophylaxis [30, 31]. For this reason injuries deeper than the epidermis, involving the extremities, joints or cartilaginous areas, as well as delayed presentation longer than nine hours require antibiotic prophylaxis [32, 33] and particularly in injuries involving a human bite [7, 34].

If there is any indication of infection, cultures should be taken and longer cultures may find slow growing pathogens. If the use of antibiotics is not thought necessary, review of the patient and wound at 48-72 hours should be mandatory in the author's opinion.

Any associated fracture underlying a penetrating wound automatically grades the injury as an open fracture and depending on the amount of soft tissue and vascular injury, its management will almost always warrant hospital admission and intravenous antibiotic therapy. These injuries need to be assessed by an appropriate ortho-plastic surgeon and treated as deemed appropriate.

INFECTIONS IN BITE INJURIES

Up to 20% of bite injuries reportedly become infected; the degree of infection varying based on the depth of injury, amount of soft tissue injury and source of injury, and can push this number nearer 50% in the immunocompromised [35-38]. Microbiologically, these injuries are often polymicrobial with a large number of both aerobic and anaerobic pathogens. The more common culprits include *Staphylococcus aureus, Steptococci* family, as well as *Haemophilus, Eikenella corrodens* and *Bacteroides* species. Numerous other anaerobic and aerobic pathogens have also been documented as being present [17, 18].

30% of human bite related injuries grow isolated cultures of *Staphylococcus aureus* that, although is a normal skin flora, is also responsible for the most severe infections and related complications. Its presence is likely to be secondary to the injury, as opposed to the other bacteria discussed below [39-42]. Staphylococcal and Streptococcal combinations are often seen in fight-bite injuries. *Eikenella corrodens* is found in a similar number of injuries and is more associated with chronic abscesses. It is a gram-negative bacillary infection and often seen in human bite related injuries [7, 17] Other anaerobic species also include *Bacteroides* and *Peptostreptococcus* type cultures [17].

Cat and dog bites are particularly difficult to treat due to the incidence of involvement of *Pasteurella multocida*, a gram-negative rod, which has also been seen in cat scratch and even wound licked injuries; related infections often presents early [17, 43]. *Pasteurella canis* is another bacterium often seen more specifically related to dog bites [44]. *Pasteurella multocida* has been seen to cause pneumonia and widespread sepsis [45]. Often its treatment is delayed by the wrong choice of antibiotic therapy in the first instance and chronic infection can lead to osteomyelitis [46].

Cat scratch disease, includes cat scratches, bites and even flea bites, and deserves mentioning. It is caused by *Bartonella henselae* and affects both immunocompromised and normal hosts, although more commonly seen in children. It presents with the primary injury and a self-limited regional lymphadenopathy, and is associated with life threatening complication in up to 14% of positive cases. This protobacterium is difficult to isolate from tissue specimens but antibodies may be picked up from blood samples. Antibiotic therapy is not indicated unless life-threatening complications are present [47, 48].

A rarer anaerobic gram-negative rod, *Capnocytophaga canimorsus*, is present in cat and dog mouth flora and has been seen to cause bacteraemia and sepsis, as well as unexpected death, particularly in the immunocompromised (including asplenia), and should be considered if a fever is present [17, 49-51] Bites involving salt or fresh water species, and even contamination with these solutions, have been shown to grow Mycobacterium species, particularly *Mycoplasma marinum* [52, 53]. *Streptobacillicus moniliformis* causes rat bite fever, more commonly seen in Asia, but related to rodent bites including squirrels, ferrets and mice. It has been seen in cat and dog bites and is usually treated well with penicillin related antibiotics [54].

MANAGEMENT OF BITE INJURIES

The ABCDE mantra of emergency management needs to be remembered when dealing with a hand bite patient, as even small wounds may distract from associated serious injuries (e.g. head injuries) the victim may have incurred when trying to evade the initial hand trauma. The nature of wounds encountered varies greatly depending on the mechanism of injury and animal species involved. Cat bites, for example, are deeper puncture-type wounds, whereas human or dog bites may have an associated degree of crush injury. With fight bite injuries it is important to remember that they can result in a breach of the joint capsule that may result in purulent arthritis [55]. Occult fractures of the metacarpal head that are easily missed on plain radiographs are another important point that needs to be kept in mind [56].

Copious oral or intravenous analgesia, especially with large wounds or venomous bites that may be extremely painful, must be administered. When administering a regional nerve block with Lignocaine or longer acting Chirocaine, care must be taken to avoid causing injury to the nerve that is being targeted.

Venomous Bites

Management of snake bites are usually dependant on the snake in question and descriptions of the reptile should be taken from the patient and witnesses and related to the appropriate authority. After immediate resuscitation, if a venomous culprit is identified the appropriate anti-venom should be administered. In the United Kingdom most snake bites relate to non-venomous bites where no antibiotic therapy is indicated. Anti-anaphylaxis therapy related to the bite is often all that is required, unless surgery is indicated due to acute regional swelling and risk of compartment syndrome [57, 58].

Other venomous bites, including marine life such as stonefish and other animals are reported and expert advice should be sought [59].

Antibiotic Choice

Current guidance shows penicillin based antibiotics such as Flucloxacillin are useful in soft tissue infections. Co-amoxiclav is more suitable for its broad spectrum of bacterial therapy and is commonly used in the management of open fractures [60-62]. Likewise, the ineffectiveness of Flucloxacillin, Erythromycin and Cephalosporins in Pasteurella infections means that Co-amoxiclav should be used routinely in animal bites and scratches [62, 63] Clindamycin is a good alternative in penicillin-allergic patients, unless Pasteurella species is present in which case discussion with a microbiologist is required [64]. Alternatively Doxycycline and Metronidazole can be used [62].

Cephalosporins have been shown to be ineffective in *Eikenella corrodens* infections, and Eikenella species have been shown to be resistant to Clindamycin and Metronidazole. If its presence is found, discussion with a microbiology specialist should be undertaken [62]. Therapy should be continued for between 10 and 14 days for cellulites, and at least 3 weeks with any deeper tissue involvement.

Virus Transmission

Most virus transmission is through human-to-human bite, although it is feasible in animal bites. HIV transmission rate is unknown but is likely to be extremely small, whereas Hepatitis C is more easily transmitted through a bite. HIV has been identified in affected patients' saliva at lower levels than that found in the blood. It is however suggested that salivary inhibitors are very good at inhibiting its infectiousness [20-23, 65, 66]. The risk of transmission through saliva is small and its exposure to a wound is not considered a risk factor for transmission, unless a positive patient's blood has also been involved. Likewise this should be considered if the victim is HIV positive and bitten by a non-infected source [4, 67].

The transmission of blood-borne viruses is dependant on many things including:

- The victim's vaccination status.
- Whether the source or victim is known to have a positive virus status: HIV, Hepatitis B surface antigen (HBsAg) or Hepatitis C positive.
- Whether the source of the injury is available or willing to be tested.

If the source is HIV positive, expert advice should be sought from a suitable source (Infectious Diseases specialist or virologist) about the use of post-exposure prophylaxis (PEP). There is no standard PEP therapy for hepatitis C, however, current advice is for Hepatitis C PCR testing at 4-6 weeks post-exposure and referral to again a suitable specialist if sero-conversion occurs. Hepatitis B transmission is the most common virus transmitted, and is documented as being 100 times more infectious than HIV and present in up to 75% of Hepatitis B positive patients' saliva. An accelerated course of Hepatitis B vaccine is often given in non-immune victims, with a single dose of hepatitis B immunoglobulin offered on presentation to all human bite related injuries.

Rabies is another virus documented to have been transmitted *via* bites, and is a mammal specific pathogen. Wild mammals such as fox, badger and bat related injuries should be thought of as suspicious. Due to its rarity, discussion with an Infectious Diseases specialist is mandatory if it is considered especially as the condition is almost invariably fatal [68].

Tetanus Prophylaxis

Human bites have been shown to transmit Clostridium tetani spores accounting for 4% of all tetanus infections, and for this reason tetanus immune status must be quantified. Regarding tetanus immunization. Rhee *et al.* [69] suggested after reviewing the literature that tetanus vaccine should be administered in traumatic wounds in the form of tetanus toxoid if the last booster was given more than 10 years prior or if history is not reliable or available, and as tetanus immunoglobulin in patients with incomplete primary immunization or to patients for whom it has been longer than 10 years since their last booster dose.

Surgical Management

Most authors advocate initial wash out of wounds in the Accident and Emergency Department for all wounds, before formal debridement takes place in theatres when indicated [31]. Necrotic material is removed together with any foreign particles e.g. chips of teeth that may be found in wounds. Great debate exists whether to repair damaged structures immediately, or after a second look after 48 h of intravenous antibiosis [70]. Elevation of the injured limb lowers the oedema and limits the associated pain and has been advocated in numerous articles, and found to be of benefit for any type of hand injury [71, 72]. A short period of splintage followed by early active mobilisation with early physiotherapy is of benefit in order to prevent adhesions from forming that would ultimately hinder the return of the injured limb to full range of movement [73, 74]. It is also important that bite injuries are reviewed in a more objective manner using outcome measures [75] and tools including the dynamometer [76] to allow a more accurate idea of their outcome, and help guide future therapies.

CONCLUSION

Although hand injuries are rarely associated with mortality, they may have significant socio-economic implications on the patient and, more often than not, their entire family [77]. Bite injuries of the hand and their related infections must therefore be monitored vigilantly and managed proactively by experts in this field of surgery. The management of such injuries needs to encompass appropriate antibiosis, a low threshold for surgical intervention, and early mobilisation after a short period of splintage to afford the injured limb the best possible chance to recover fully.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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