Bite wounds to the hand – a review

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ABSTRACT: Bite wounds occur as a result of bite by an animal or a human. They are relatively frequent due to the growing number of pets living with people, as well as from inadequate human-animal interactions. The knowledge of most surgeons about the management of these injuries is relatively outdated, whereas the current literature points to important changes in this field. The article presents several aspects concerning epidemiology, classification, bacteriology, and characteristics of bite wounds to the hand. Based on the actual literature, detailed rules for the management of these injuries are described. This information may prove useful in the daily practice of surgeons and doctors at emergency departments who are frequently faced with bite wounds.

KEYWORDS: antibiotic therapy, bite wound, hand infection, treatment of bite injuries

INTRODUCTION

Bite wounds occur as a result of bite by an animal (domesticated or wild) or a human. They are relatively frequent due to the increasing number of pets kept by humans, as well as inappropriate human-animal interactions. Bite wounds vary in shape, extent and depth and are primarily contaminated with mixed bacterial flora. Although not all bite wounds become infected, they require special treatment due to potentially serious complications.

EPIDEMIOLOGY OF BITE WOUNDS

The literature indicates estimates of the number of bite wounds inflicted by animals or humans in different countries. In the United States, there are approx. 1–2 million dog bites and approx. 400 thousand cat bites, which is ca. 200 bite wounds per 100,000 inhabitants yearly [1]. However, it is estimated that in Europe there are 175–740 animal bites per 100,000 residents yearly. In Germany, there are approx. 35 thousand bites from dogs and cats that have an owner (recorded) and approx. 1 million bites from unregistered (ownerless) dogs and cats [2]. There are no data available for Poland; there are between 10 and 15 people bitten by dogs or cats who report to the author’s hospital emergency department monthly. Of these, at least one person requires hospitalization for surgical treatment of the injury (tendon injury, bone fracture) or an infection that requires incision and drainage. It therefore represents a rather significant problem, the scale of which is systematically growing.

Dog bites account for approx. 70–80% of all events, followed by cat bites and scratches (5–15%), as well as human bite wounds (3–23%) [3]. The victims are usually dog or cat owners, and people working with animals, such as veterinarians and farmers, who often keep animals on their farms. The most common bite site in adults and older children are by far the hands, while children <10 years are more often bitten in the head and neck [3, 4].

Similarly to burns, bite wounds have been classified depending on the depth and the presence of any tissue cavity or necrosis [2]. The three-grade scale divides bite wounds into superficial (1°), deep (2°), and complicated (3°) (Tab. 1). This classification is not as important as the burn classification and has minor clinical significance, however, it may be useful in record keeping, research, and evaluation of treatment outcomes. Most bite wounds encountered in practice are grade I. It seems that this classification lacks a separate category of deep bite wounds with damage to hand structures such as tendons, nerves, joints, and bone fractures. Such a category would emphasize the significance of wounds that require repair of damaged structures and which may lead to impaired hand function.

CLASSIFICATION OF THE SEVERITY OF BITE WOUNDS

Similarly to burns, bite wounds have been classified depending on the depth and the presence of any tissue cavity or necrosis [2].
Algorithm for bite wound management.

Tab. I. Classification of the severity of bite wounds.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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<tbody>
<tr>
<td>I</td>
<td>Bruising of the skin by animal teeth; Scratch on the skin;</td>
</tr>
<tr>
<td></td>
<td>Superficial, single skin wound; Skin cavity caused by a tooth (discontinuity);</td>
</tr>
<tr>
<td></td>
<td>Skin abrasion with part of the subcutaneous tissue</td>
</tr>
<tr>
<td>II</td>
<td>The wound is deep, reaching the fascia and muscles.</td>
</tr>
<tr>
<td>III</td>
<td>Wound with soft tissue defect and necrosis.</td>
</tr>
</tbody>
</table>

Tab. II. Algorithm for bite wound management.

- Wound disinfection and irrigation.
- Hand x-ray if bitten by large dogs.
- Debridement – excision of devitalized and torn skin tissues.
- Initial suturing of wound or leaving it “open” to heal.
- Incision of the skin and subcutaneous tissue at the site of the bite (e.g., wounds from cat’s teeth).
- Secondary suturing of the wound after the symptoms of inflammation have subsided and after “cleansing”.
- Antibiotic therapy.
- Prophylaxis against tetanus and possibly against rabies (where necessary).

20–25% by humans, and 30–50% by cats [2]. The author’s experience and most publications show that wounds from cat bites are the most susceptible to infection and must therefore be treated with particular care. Although on average merely less than 1/5 of bite wounds are infected, the risk of infection is much greater in contaminated home or “street” wounds. Therefore, prophylactic antibiotic therapy is prescribed in the treatment of bite wounds in most textbooks and in surgical practice.

TIME FROM BITE TO MEDICAL CONSULTATION

This is an important parameter which determines the course of wound healing. The literature data indicate a statistically significantly higher risk of infection and worse treatment outcomes for bite wounds in patients who report to the doctor 8–12 hours after the bite [1–3]. Delayed decontamination, cleaning and debridement of the wound create favorable conditions for the multiplication of bacteria. This applies to all wounds, but especially those inflicted by cats and people. Aged bite wounds should be treated without suturing and the patient should be administered an antibiotic.

ANTIBIOTICS IN BITE WOUNDS

This is a somewhat controversial issue. There is no conclusive scientific evidence that an antibiotic should be used in all cases of bite wounds inflicted by dogs. The results of several meta-analyses show that an antibiotic administered after a dog bite does not statistically significantly reduce the risk of wound infection [8, 9]. On the other hand, antibiotic therapy is recommended in people with immunodeficiency, diabetes, the elderly, cat and human bites, and in old wounds [10–13]. Despite such research results, antibiotic therapy is widely used in the treatment of bite wounds due to the well-founded fear of infection. Antibiotics do not always prevent infection. If an infection develops, a swab should be taken from the wound and a targeted antibiotic should be administered after an antibiogram is obtained.

Amoxicillin/clavulanate is the most frequent antibiotic used in the prophylaxis of infection in bite wounds. Most bacteria that contaminate wounds are susceptible to it, therefore there is no need to use other antibiotics, or to use two at the same time. Treatment of infected wounds involves the use of a targeted antibiotic based on the result of the antibiogram.

ALGORITHM FOR BITE WOUND MANAGEMENT

Superficial bite wounds (grade I) can be treated on an outpatient basis, in the treatment rooms of outpatient clinics or at hospital emergency departments. On the other hand, deep and extensive wounds with tissue defects, suspected of damage to the hand structures, as well as wounds with symptoms of infection, should be treated by surgeons, orthopedists, and optimally by hand surgeons. Treatment may be outpatient or inpatient, depending on the size and severity of the wound or infection. Traditional treatment of bite wounds, which is reported even in relatively new textbooks, involves decontamination of the wound, debridement in the relevant cases (torn skin, devitalized tissues), and wound healing via open method, without sutures. For this purpose, it is usually recommended to use an antibiotic, a tetanus toxoid and, in the case of bite inflicted by an unknown or wild animal – post-exposure rabies prophylaxis. On the other hand, publications from the recent decade indicate some changes to this traditional regimen, which will be discussed here.

Large wounds (over 3 cm long, with jagged edges, deep, with a suspicion of damage to tendons, nerves) should undergo debridement under regional or even general anesthesia (in the case of children, always general anesthesia). Large wounds should undergo debridement at the operating theater, while smaller wounds can be treated in the HED surgery room under local anesthesia. The bite wound algorithm indicated in Tab. II. will be discussed further in the following sections.

Disinfect and irrigate the wound

As with any other wound, a bite wound should be decontaminated with a disinfectant such as octenidine (Octenisept) or an iodine-based agent. Irrigation of a bite wound with 0.9% NaCl solution is also recommended as it permits rinsing contaminated content from the wound, e.g., blood, remnants of animal saliva, foreign bodies, and parts of dead tissue. Most authors consider it harmful to rinse the inside of the wound with fluid administered through drains and under pressure (e.g., through a syringe). The author’s clinic practices rinsing (by pouring) on open, bleeding bite wounds with approx. 500 ml of saline solution. The author’s experience shows that this procedure is safe and yields more benefits than threats.

Hand and/or wrist X-ray

Bites inflicted by large animals, large dogs or farm animals such as horses, cows, can cause injuries but also fractures to the bones of the digits, metacarpus, wrist or the distal end of the radius bone. In such cases, it is important to follow up the fracture by performing an x-ray of the damaged part of the limb.
**Wound debridement**

Not all bite wounds require debridement. Grade I wounds (in the classification given above) usually do not require revision, except for those with detachment of subcutaneous tissue and skin. However, this is required in the case of deep, aged wounds, with clearly visible tissues with poor blood supply and dead tissue, as well as contaminated with foreign bodies. An indication for revision are also wounds with exposure of muscles, tendons, and nerves. Such wounds must be revised under regional anaesthesia and at the operating theater. Major grade I wounds can be managed at the operating room under relevant anaesthesia. It is recommended to excise tissues of questionable viability as necrosis is an excellent breeding ground for bacteria, which promotes infection. Excision should be purposive but sparing so that the wound can be closed. If the skin defect is large after debridement and there are difficulties with would closure, it is better to leave it open, and to cover the defect with a skin graft after obtaining clean granulation. High-tension wound closure usually results in necrosis of the wound edges.

**Primary suturing or leaving the wound unsutured**

Current medical knowledge allows for suturing bite wounds inflicted by dogs when the patient reports to the doctor no later than 8–12 hours after the bite [13–15]. There is plenty of scientific evidence that this does not increase the risk of wound infection, provided that the wound is rinsed and revised first, i.e., it is cleaned of foreign bodies and tissues of doubtful viability, and that torn skin is evened out [1, 2, 14]. However, leaving a wound unsutured is not a mistake and every surgeon has the right to choose the safer (in his opinion) treatment option. Also, in any doubtful case where the debridement is incomplete, it is better not to close the wound. It is not recommended to suture bite wounds from cats and people. Wounds inflicted by dogs are closed with guiding sutures, which means large spaces between individual sutures, e.g., a 3 cm long wound is closed with up to 2 sutures. This technique allows to drain the exudate contaminated with bacteria from the wound, prevents fluid accumulation, and thus reduces the risk of infection.

**Incision of the skin and subcutaneous tissue above the bite site**

In some bite wounds, primary incision is recommended. This is especially true for bites inflicted by cats, which have thin and sharp teeth that cause stab wounds. In such a mechanism, bacteria on the teeth and in saliva are introduced relatively deep into the subcutaneous tissue, where they have good conditions for multiplication. The stab wound is closed, with no outflow of contents, which further contributes to infection. The literature data indicate a statistically significantly higher risk of wound infection after cat bites compared to dog bites [1, 3, 13, 14]. Some wild and farmed animals, such as squirrels, ferrets, chinchillas and foxes, also have cat-like teeth, but such bites are rare. For these reasons, primary incision of cat bite wounds is recommended. After disinfecting the bite site, it is anesthetized with 2% lignocaine and the skin is incised at the appropriate length, all the way to the subcutaneous tissue. On the fingers, an incision of about 2 cm long will be sufficient, while it should be longer on the metacarpus and wrist. Incisions made on the palmar side of the hand tend to close, so they require the placement of a rigid tube inside, e.g., from an airway suction probe cut longitudinally in the shape of a gutter. The author’s experience shows that this incision is very beneficial and – in most cases – prevents wound infection. However, in such case the treatment is significantly prolonged; it is important to remember to take a swab from such a wound after incision.

Sometimes phlegmon develops despite the primary incision (Fig. 1A); then, the incision must be significantly widened (Fig. 1B) and, if necessary, the antibiotic should be changed to a targeted one, based on the result of the antibiogram.
Secondary suturing after the inflammation symptoms have subsided

If a bite wound is treated with the open method, then after 4–5 days, and in the absence of symptoms of infection, it can be sewn with several guiding sutures, similar to the primary suturing. This also applies to wounds that were infected but became cleansed after a few days of treatment, and wounds subject to primary incision, for example those inflicted by cats, discussed in the previous paragraph. It is important to remember about inserting an appropriate drain in large, flap wounds with detachment of the skin and subcutaneous tissue, which will facilitate the drainage of blood and exudate from the wound. Suturing the wound significantly shortens the healing period and improves the aesthetics of the scar (Fig. 2.), as well as the functional results of the treatment, as it allows for an earlier start of rehabilitation.

Antibiotic therapy

As already mentioned, in surgical practice antibiotics are used in virtually most dog bites and in all wounds inflicted by cats and humans. Although such a procedure is not unequivocally justified in the results of scientific research, it still is common [11, 14]. The antibiotic of first choice is amoxicillin / clavulanate, in a dose 2 x 1 g orally. There is no justification for starting treatment with other antibiotics, e.g., third-generation generation cephalosporins, ciprofloxacin or clindamycin. There is also no justification for the use of metronidazole. If, despite proper wound care and antibiotic therapy, an infection develops, a swab from the wound should be taken and – after obtaining the result of the antibiogram – the patient should be started on a targeted antibiotic.

Some cases of dog bites are associated merely with bruising of the skin and a scratch or dent in the skin caused by the dog’s tooth. If the victim is the dog owner, they usually do not seek medical attention. It seems that in such cases it is enough to decontaminate the site of injury without the use of an antibiotic. However, if disturbing symptoms such as pain, redness and swelling appear at the site of the bite or scratch within several hours, then the wound should be approached as infected and treated not only with an antibiotic, but also managed with a prophylactic incision.

Prophylaxis against tetanus and rabies

The oral cavity of animals and humans may contain bacteria or spores of Clostridium tetani, and therefore bite wounds require standard tetanus prophylaxis [1, 7, 13, 15]. Each person who has undergone vaccinations in accordance with the immunization schedule exhibits immunity to tetanus, which lasts up to approx. 25 years of age. Thus, young people require no booster dose of the tetanus toxoid. However, it is obligatory to administer one dose of tetanus toxoid and repeat it after 1 and 6 months (booster vaccination) in adults and older people.

Rabies represents a potential risk for bite wounds inflicted by wild animals and pets (mainly dogs) that have not been vaccinated against it. The risk that a pet living in the city, even unvaccinated, may have rabies is minimal. In contrast, dogs living in the countryside that may come into contact with wild animals can also become infected with rabies. The surgical proceeding in this aspect of bite wounds is standard. If the patient was bitten by an animal that he owns or he knows the owner of that animal, then it remains with the patient to determine whether or not that animal has been vaccinated against rabies. If an animal has an owner, but has not been vaccinated, then it must be monitored for possible symptoms of disease under the supervision of a veterinarian. If a patient was bitten by an unknown or wild animal, then they should be referred for consultation to the infectious disease clinic, which is located at each hospital with such a ward. After consultation, some patients will require a rabies vaccine to prevent the development of this deadly condition. This applies to bites from wild animals, dogs and cats without an owner and those whose owner remains unidentified.

Bitten wounds with damage to hand structures

In the author’s practice, such injuries are relatively rare, estimated in approx. 2–5% of all bitten wounds, mainly caused by dogs. The most frequently damaged tendons are the extensors of the fingers on the dorsal side of the metacarpus or wrist (Fig. 3.), much less finger flexor tendons and wrist flexors/extensors. Nerve injuries of...
the medial and ulnar nerves are also rare. Finger bites can be complicated by digital nerve injuries, breaks or contusions. Bite wounds with damaged hand structures should be treated at specialized hand surgery departments.

**Clenched fist injury**

Hitting another person’s teeth during a fight with a fist may injure the dorsal surface of the metacarpus (known as the “knuckles”) (Fig. 4.). When hitting another person’s teeth, the skin over the head of the metacarpal bone is tense and tears easily [3]. In an article which discussed such injuries, the authors noted that of 191 patients with these injuries, 128 (67%) had a wound that penetrated the extensor tendon and the articular capsule of the metacarpophalangeal joint. The consequence may be purulent infection of the joint, bone infection, or phlegmon of the dorsal part of the metacarpus. When the force of the impact is large enough, in addition to injuring the skin, the trauma may cause a subcapital fractures of the metacarpal bone. Such a wound is classified as bitten and belongs to grade III of the previously described classification. Since the extensor tendon of the little finger runs just under the skin here, it also becomes contamintated and may even (although rarely) be damaged. Due to the aforementioned circumstances, a clenched fist injury should be regarded as very susceptible to infection. The wound should be decontaminated, rinsed, and subject to debridement. It is recommended to immobilize the fingers in the splint for a period of about a week and to apply antibiotic therapy [3, 5, 13, 15]. If there is a wound infection, treatment should be based on the antibiogram. Subcapital fractures of the metacarpal bones can be treated conservatively, even when there is an angular displacement up to 30°. If the displacement is larger, then surgery is scheduled after the wound has healed.

**HUMAN BITES**

Human bite wounds are caused by various factors: aggression, often stimulated by alcohol, excesses or pathological sexual behavior, self-harm in the course of mental illness, nervous behavior (e.g., when biting nails) and in mentally handicapped people [3, 10, 12]. The literature reports the previously described punches in the teeth of another person during a fight as the most common cause of injuries classified as bite wounds [3, 14, 15]. These injuries affect young males almost exclusively, but in general, men and women are as likely to be bitten by humans. More than 50% of these wounds are located on the hands. Human bite wounds are contaminated with a slightly different flora than animal bite wounds. It is commonly believed that they are more dangerous and carry a higher risk of infection, but this is not supported by research findings. Human bites often cause merely bruising of the skin and ecchymoses without an open wound. Eikenella corrodens is the most commonly cultured bacterium in infected bite wounds, alongside staphylococcus aureus and various streptococci. It should also be remembered that human bites can cause infection with dangerous viruses, especially hepatitis B and C virus and HIV.

**REFERENCES**

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