

# Rat bite injuries in children: description of a novel classification

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## Abstract

**Purpose:** Rats are common intruders into human settlements. Apart from their role as disease vectors, they can also cause bite injuries. We describe the clinical course of a series of children with rat bites, and characterise the injuries.

**Methods:** A retrospective review of hospital records of children admitted for rat bites in a large regional hospital was undertaken. The demographics, wound characteristics, treatment given and clinical outcome of the patients are described.

**Results:** Fifty-nine children, with a mean age of 3.7 years, were admitted for rat bites. Three distinct types of wounds were treated: superficial scratches (Type I), deeper bites often with infection and ulceration (Type II) and full-thickness with loss of skin or underlying soft tissues (Type III). Few wounds displayed signs of inflammation. Only some Type II injuries required urgent local surgery in the form of drainage and debridement. Type III wounds required a skin graft. All patients recovered.

**Conclusion:** We suggest that treatment of rat bites should be based on the wound type. Most patients do not require hospital admission or antibiotic treatment. Treatment should be mostly conservative wound care management. Surgery is only indicated for drainage of pus, debridement, skin graft or rarely reconstruction.

**Keywords:** Rat bite; Wound classification; Wound management; Bite wounds

## Background

Ever since man started congregating in towns and cities, rats have followed into these spaces. Rats are attracted by the availability of food in areas of human settlement. Poor areas of cities are more plagued by rats because of lack of proper sanitation and hygiene, as well as deficient waste disposal infrastructure [1]. Rats, along with their infected fleas, commonly carry pathogens important to humans. While the epidemics of centuries ago no longer occur, sporadic cases of bubonic plague are still reported [2]. Rat bite remains important because of a relatively high mortality rate due to disease transmission [3]. In addition to their role as disease vectors, bacterial infection of rat bite wounds can cause significant morbidity [4, 5].

This can be important in vulnerable patients such as diabetics [6, 7] and possibly patients with HIV-AIDS. The peri-urban townships and squatter camps in South Africa are notoriously infested with rats [1]. Little has been reported on rat bite injury in the developing world. While the natural history, epidemiology and risk factors for rat bite have been published, there has not been a systematic description of the actual rat bite wound. We describe herein a case series of rat bites in children. We classify the wounds according to their physical characteristics. We noted the treatment given for different types of wound including the need for surgery.

## **Methods**

A retrospective descriptive study was performed by review of hospital files at Tembisa Provincial Hospital which is situated in an impoverished township near Johannesburg, South Africa. The study was approved by the Research Ethics Committee of the Faculty of Health Sciences of the University of Pretoria (Reference number 53/2016). All patients admitted to the paediatric surgery ward for rat bites during the period from 2011 to 2015 were included in the study. Patient demographics, vital signs at presentation, the site of the bite wound and length of hospital stay were recorded. A precise description of the wounds was used to classify them into types using the following characteristics: depth, inflammatory changes, tissue necrosis and scab, exposure of deep tissue or loss of tissue. Management of the wound, including surgical treatment given, as well as the wound and patient outcomes were used in the development of a rat bite wound classification.

## **Statistical analysis**

Continuous data were computed as means. Pearson's Chi-squared test was used to compare the means of categorical variables. In the case of insufficient numbers in a category, Fisher's exact test was employed. Correlations were sought between patient demographics, clinical presentation, wound type, wound site and the course of the illness. A cutoff of 12 months of age was used to categorise patients into infants or older children. A patient temperature of more than 38 °C at presentation was used as an indicator of a systemic inflammatory response.

## **Results**

Fifty-nine children were treated for rat bites during the study period. Most of the patients resided in the more impoverished informal settlements in and around Tembisa township. Demographics and clinical characteristics of the patients are shown in Table 1. There was little difference in the sex distribution of the children. Ages of the children ranged between 2 weeks and 12 years (mean 3 years and 5 months), 16 (27%) being infants (< 12 months). Twenty patients (34%) presented relatively late after the bite (> 48 h). A majority of bites (36 patients, 61%) occurred on the head. The patients' temperature at presentation ranged up to 40 °C (mean 37.6 °C). Hospital stay ranged between 1 and 60 (mean 5.4) days.

**Table 1 Characteristics of patients with rat bite injuries (n 59)**

Sex	
Male	34 (58%)
Female	25 (42%)
Age: mean (range)	
3 years 5 months (2 weeks–12 years)	
< 12 months	16
> 12 months	43
Anatomical location of bite:	
Head	36
Extremities	17
Multiple sites	6
Temperature: mean (range)	
	37.6 °C (36– 40)
Time to presentation:	
< 48 h	33
> 48 h	20
Hospital stay: mean (range) days	
5.4	(1–60)

There were different injury types. Some were superficial scratches or cuts, and some were deeper injuries surrounded by inflammation and a few involved full-thickness loss of skin and even loss of deeper tissues. The clinical manifestation of the wounds differed. The children with superficial wounds displayed no local or systemic reaction. Many deeper wounds were infected. The wounds of the children with loss of tissue had no signs of inflammation and there was no systemic response. These clinical characteristics were used to describe three basic wound types which were designated types I, II and III wounds (Table 2 and Fig. 1). The majority were type II (moderate) wounds (45 of 59, 76%), 11 (19%) were type I (mild) and 3 (5%) type III (severe) wounds.

**Table 2.** Rat bite wound classification

Type	Description
I (mild)	Multiple superficial or partial skin thickness wounds which often resemble scratches or fine cuts. Minimal or no inflammatory changes in the skin
II (moderate)	A single deep bite wound. Pronounced local inflammation. Central necrotic eschar overlying deep otherwise clean-based ulcer. May be associated with an abscess
III (severe)	Deep wound with full thickness skin loss involving exposure or partial loss of underlying fascia or muscle. Usually sharp and clean edges with minimal inflammation



**Fig. 1.** Representative photos of types of rat bite injuries. **A** Type I = Mild, **B** Type II = Moderate, **C** Type III = Severe **(a)** on admission **(b)** at follow-up after skin grafting

Clinical characteristics of patients with different types of wounds are shown in Table 3. Fewer younger patients (less than 12 months) had deep ulcers or skin loss (8 of 16, 50%), and their temperature was less than 38 °C ( $p = 0.024$ ). Older children more commonly had deeper infected wounds ( $p < 0.001$ ) with temperature above 38 °C ( $p = 0.077$ ). The length of hospital stay was not influenced by the type of injury ( $p = 0.74$ ). There was no correlation between the patient's age and the site of the bite wound ( $p = 0.83$ ).

**Table 3.** Comparison of rat bite wound types with regard to patient age, temperature, hospital stay and wound site categories

A	Type I	Type II and III	p—value
<b>B</b>			
Patient age			
<12 months (n 16)	8	8	≤ 0.001
>12 months (n 43)	3	40	
Temperature			
<38 °C (n 38) <sup>#</sup>	10	28	0.077*
>38 °C (n 21)	1	20	
Hospital stay			
<72 h (n 35)	6	29	0.077*
>72 h (n 23)	5	18	
<b>B</b>			
Wound site by age	<12 months	>12 months	0.83*
Head (n 36: 61%)	9	27	
Limb (n 17: 29%)	5	12	
Mixed (n 6: 10%)	2	4	

\*Fisher's exact test

<sup>#</sup> 24 (63%) more than 12 months, p = 0.024

All the patients received prophylactic tetanus vaccination. This is routine for all wounds in our hospital, whether for vaccination initiation or boost. Antibiotics were administered to all the patients: monotherapy in 30 and combination therapy in 28. Ten patients received rabies prophylaxis. Most patients responded well to local wound care. Five patients required surgical treatment: 3 patients with type II wounds had incision, drainage of pus and debridement, and 2 patients with Type III wounds required skin grafting.

All the patients recovered, with some disfigurement in the few patients with type III wounds. Figure 1 shows representative examples of the types of rat wounds encountered. Figure 1c shows the wound of a child who lost skin and muscle, including the eyelid. The child lost the eye because of the injury which was managed by skin graft [Fig. 1C(b)].

## Discussion

We present a series of rat bites in children. They were from an impoverished township which is severely infested with rats. This accords with the known epidemiology of rat infestations in most urban settlements in the world [1, 2, 8]. Rats are scavengers of edible material, but will occasionally attempt to feed on living tissue including human flesh. The patients described in this study demonstrated certain characteristics, some of which have previously been described by others. Rats are the most common inflictors of animal bites in young children [1]. The bites occur mainly on the hands and face [1, 9]. The head was also the site of the bite wound in 61% of our patients. Children are usually younger than 5 years of age [1, 4]. Twenty-seven percent of the children in our series were less than 12 months of age.

The bite wounds described here are apparently more severe than in previous studies. Ordog et al. described punctures, lacerations and ecchymoses [4], whereas several of our patients had significantly deeper wounds, some with tissue loss requiring surgery. Full-thickness loss of skin is unusual. Nevertheless, loss of facial tissue similar to our case depicted in Fig. 1c has

been published previously [10, 11]. Wound infection seems to be uncommon in rat bites [4, 9], as also demonstrated in this study. However, some of the deeper confined wounds were infected and a few of these required local surgical procedures. These wounds occurred more in children older than 12 months.

Anti-rabies vaccination was administered by emergency room treating doctors to 10 (17%) of our patients. Although this was not necessary, it was nevertheless prescribed by doctors who were uncertain of the approach to rabies vaccine in rat bites because of the lack of a relevant protocol. Rabies due to a rat bite has never been conclusively demonstrated and prophylaxis is not necessary [4, 12]. Only one unproven case has been reported [13].

We propose a classification for rat bite wounds based on the characteristics of the wound, the clinical manifestations and treatment that was given in our patients. Type I wounds, which are fine cuts or scratches, probably result from exploratory bites. They have been previously characterised [14]. In our opinion, they require only non-specific basic wound care, and the patients do not require admission to hospital. Administration of systemic antibiotics to these patients is unnecessary, as has also been proposed by others [15]. The type II wounds, which are characterised by deep injury, and may be covered by a scab, are more likely to be infected. Cellulitis surrounding the wound or an associated abscess may require more intensive treatment in the form of antibiotics, abscess drainage or debridement. Antibiotic administration has been recommended previously for this type of wound [15]. Type III wounds which consist of full-thickness loss of skin and possibly even deeper tissue require more concerted wound care and possibly surgical reconstruction or skin graft. Type I and III wounds are usually not overtly septic.

The general unfamiliarity of doctors with rat bite injuries was apparent in this study. Cognisance of the classification of wounds and the principles described in this report could aid in the appropriate management of children with rat bite wounds.

Caution is advised in patients with diabetes mellitus. Diabetic foot ulceration and a significant loss of life and limb in adult diabetic patients bitten by rats have been reported [6, 7]. The scenario of diabetic angiopathy or neuropathy complicated by rat bite is unlikely in children.

## **Conclusion**

We describe rat bite injuries in children and propose a classification of rat bite wounds. We suggest treatment guidelines based on the type of wound. Type I superficial wounds require only basic wound care and do not need hospital admission. Type II wounds require antibiotics and may require local surgical treatment. Type III full thickness wounds require skin graft or surgical reconstruction.

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