



Snakebites of fingers or toes by Viperidae family members : An orthopaedic approach

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The purpose of this study was to review current principles of therapy for affected patients and determine whether an emergent surgical approach or expectant management should be selected in cases of snakebites of fingers or toes by Viperidae family members. Over the past five years (January 2004 to December 2009), 12 patients bitten by *Vipera ammodytes* were admitted in our department. We retrospectively reviewed their demographic and epidemiological characteristics as well as their symptoms, laboratory findings, and complications. All snake bites occurred at the extremities (fingers and toes). The main complications were oedema, disseminated intravascular coagulation, and decrease in haematocrit. None of the patients developed compartment syndrome or required surgical debridement. The majority of the patients with snakebites of fingers or toes by *Vipera ammodytes* can be treated conservatively. Surgery is indicated only in case of compartment syndrome, where fasciotomies should be performed without delay after diagnosis.

Keywords : snakebite ; *Vipera ammodytes* ; compartment syndrome ; fasciotomy.

INTRODUCTION

Snake envenomation is a medical emergency causing both local and systemic effects. The poison of *Vipera ammodytes* is a chemically complex mixture which contains many proteins responsible for the majority of systemic symptoms and local tissue

damage, such as haematoxin and neurotoxin (6). Additionally, it is rich in enzymatically active proteins that include proteolytic and hydrolytic enzymes. The dose of venom delivered in each bite depends on the size of the snake, the size of the victim, and the location of the bite. The severity of the reaction is mainly related to the size of the patient and his/her sensitivity to the venom, the size of the snake, the location, depth, and number of bites (20). Because of their smaller size, children receive a relatively higher dose of venom ; there is however no increase in the morbidity and mortality rates in children (2). On the other hand, deposition of venom into subcutaneous tissues has different manifestations than injection into deeper tissues after fascia penetration (11).

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Systemic symptoms and signs after bites from poisonous European snakes of the Viperidae family include haemolysis, hypotension, tachycardia, acute renal failure, fever, generalized oedema, blurred vision, and convulsions (6). Common allergic reactions, possibly IgE-mediated, are bronchospasm, urticaria, and angioedema (18). Local tissue damage after envenomation in an extremity is usually impressive and manifested by severe oedema, ecchymosis, pain, tenderness, paraesthesia, and hypaesthesia. Extravasation of plasma and erythrocytes as a result of poison-induced capillary leak is the cause of oedema and ecchymosis that follow deposition of venom in subcutaneous tissues (12). If left untreated, local necrosis with tissue loss may develop.

The purpose of this study was to review current principles of therapy and to determine whether an emergent surgical approach or expectant management should be selected in cases of snakebites of fingers or toes by Viperidae family members.

PATIENTS AND METHODS

From January 2004 to December 2009, 12 patients were admitted in our hospital due to snake bite. Four patients were bitten on the fingers and two on the toes. All patients were from North-Western Greece and they were bitten by *Vipera ammodytes* (Fig. 1). All snake bites took place from April through October. Data including demographic characteristics, laboratory findings, treatment, and outcome were collected retrospectively from our medical records.

All patients except one presented to the emergency department within an hour after the bite without any previous medical intervention. One patient received first aid at a regional health care center. Seven of our patients were females and five were males. All patients except one were over 50 years old (range : 42-88 years ; mean age : 69.5 years) and all of them were employed in the countryside (Table I). In all cases intravenous access and hydration with monitoring of the electrolyte balance and urine output was performed in the emergency department. The wound was cleaned and covered with a sterile dressing. Vital signs were recorded every hour. Prophylaxis with tetanus immune globulin at a dosage of 250 IU intramuscularly was given to all patients, as well as antibiotic prophylaxis with a second generation cephalosporin in order to prevent wound infection.



Fig. 1. — *Vipera ammodytes*, a member of Viperidae family, is the most common poisonous snake in Greece.

Analgesics and antiallergics were also administered when necessary. Intravenous administration of antivenom was not done in any of our patients. The mean follow-up period was 16 months (range : 12 to 21 months).

Patients were classified according to the system described by Downey *et al* (3) : a) in grade 0 there is no envenomation but swelling and erythema around the fang marks below 2.5 cm ; b) grade 1 corresponds to swelling and erythema of 2.5-15 cm but no systemic signs ; c) in grade 2 the swelling and erythema are 15-40 cm with mild systemic signs ; d) in grade 3 the swelling and erythema are greater than 40 cm with systemic signs ; and e) in grade 4 there are severe systemic signs including coma and shock. The presence of compartment syndrome was evaluated clinically. No intracompartment pressure monitoring was employed to facilitate diagnosis.

RESULTS

The fang marks were visible in all patients. Ten of our patients had severe pain and ecchymosis at the site of the snake bite. Two patients had tachycardia and one had palpable cervical lymph nodes ipsilateral to the bite. According to Downey *et al*'s system one patient was classified as grade 0, 4 patients were classified as grade 1, 3 patients as grade 2, and 4 patients as grade 3 (Table I).

The hospital stay ranged from 1 to 8 days (mean duration : 6 days). None of our patients developed fever during hospitalization. No clinical or laboratory signs of infection were noted. In 4 patients

Table I. — Demographic and clinical characteristics of the study population

Patient	Sex	Age	Employment	Downey <i>et al.</i> classification (3)	Complications
1	Female	76	Farmer	1	Oedema
2	Male	42	Shepherd	3	Oedema, DIC
3	Female	64	Farmer	3	Oedema, DIC
4	Female	88	Shepherd	2	Oedema, DIC, Low Ht
5	Female	82	Shepherd	1	Oedema
6	Male	80	Farmer	0	None
7	Male	76	Farmer	2	Oedema
8	Male	57	Shepherd	2	Oedema, DIC
9	Female	60	Farmer	3	Oedema
10	Female	61	Farmer	3	Oedema
11	Female	72	Shepherd	1	Oedema
12	Male	79	Shepherd	1	Oedema

DIC = Disseminated Intravascular Coagulation ; Ht = Haematocrit.

disseminated intravascular coagulation (DIC) was present (Table I). In one of them, a significant decrease in haematocrit was also recorded (lower value recorded : 21%). Administration of blood and blood products was the treatment of choice for these patients.

Compartment syndrome was not diagnosed in any of our patients despite the severe oedema of the extremity and the presence of black eschars in all fingers and toes involved. Thus, emergent surgical intervention, such as fasciotomy or digit dermatomy, was not performed in any patient. Two patients underwent color duplex examination because of severe oedema in the lower extremities. No abnormal findings were recorded.

No functional or cosmetic deficit was recorded in any of the involved fingers or toes. None of our patients developed late serum sickness and none of them died.

DISCUSSION

Snake bites represent a major problem which requires hospitalization and a multidisciplinary approach. Internal medicine, pediatrics, and orthopaedics are some of the specialties which are

essential for the treatment of a snake bite (4). In Greece, the most common poisonous snake is a member of the Viperidae family, which belongs to the subgroup Viperinae which includes *Vipera ammodytes*, *Vipera xanthine*, *Vipera labetina*, *Vipera berus*, and *Vipera ursinii* (6). The snake venom is rich in proteins among which neurotoxin, cytotoxin, and haematoxin are the most important (6).

Factors which play a basic role in the severity of a snake bite are the nature, location and depth of the bite, as well as the number of bites, the amount of venom injected, the species, and the size of the snake. The amount of venom depends on the snake's size : larger snakes tend to have more venom than the smaller of the same species (6). There are also factors from the victim's side such as the age and the size and the victim's sensitivity to the venom that may affect the severity of a snake bite (20).

Almost all snake bites take place from March to October (6). The majority of the victims in Greece are middle aged persons. In our series the victims were all but one over fifty years old, in contrast with other countries where the victims are usually young individuals. This can probably be explained



Fig. 2. — A 64-year-old female farmer was bitten on the distal phalanx of the right middle finger by *Vipera ammodytes*.



Fig. 4. — Same patient as in Figure 2. Ten days after admission, oedema and ecchymosis are limited to the distal and middle phalanx of the middle finger.



Fig. 3. — Same patient as in Figure 2. Note the oedema and ecchymosis extending to the right forearm, arm, and ipsilateral thoracic wall. Clinical examination revealed palpable cervical lymph nodes and tachycardia. The patient was classified as grade 3 according to Downey *et al*'s system.



Fig. 5. — Same patient as in Figure 2. One month after admission oedema and ecchymosis have completely resolved. A black eschar is noted at the site of the initial bite.

by the fact that people living in the Greek countryside and employed in the fields are older than in other places such as cities, so the possibility of an accidental snake bite is higher for the specific ages (6). Frangides *et al* (6) presented a large series of snake bites in Greece where 57.8% were male and 75.51% were farmers or shepherds. The bites took place mostly at the upper extremity and the feet.

The treatment of snake envenomation, conservatively or by fasciotomy continues to be a controversial subject (19). Some authors support early

fasciotomy in the treatment of all cases of envenomation (9,10). On the other hand, others advocate that fasciotomy is never necessary when antivenom has been adequate (20). In line with Garfin *et al* (8) as well as Stewart *et al* (22), we suggest that surgery does not improve outcome and should be limited to refractory cases. Fasciotomy may result in disfiguring scars, contractures, nerve damage, significantly lengthening the course of treatment and frequently associated with permanent loss of limb function (11). Severe oedema and black eschars were present in all fingers and toes involved in our series. However, compartment syndrome requiring fasciotomy was not diagnosed in any of our patients even though antivenom was not administered.

The development of compartment syndrome is a rare complication after a snake bite. Clinical signs and symptoms of compartment syndrome include : 1) Pain out of proportion to the apparent injury ; 2) Hypoaesthesia in the distribution of nerves passing through the compartment in question ; 3) Pain on passive stretch of the muscles within the compartment ; 4) Tenseness of the compartment on palpation ; and 5) Weakness of the involved muscles (14,23). Several hypotheses for the development of compartment syndrome following snake bites have been proposed. Garfin *et al* (7) supported that venom deposited intramuscularly causes release of tissue fluids into the involved compartment resulting in elevated pressures. In addition, it has been shown that when venom is injected into a muscle compartment, myonecrosis is related primarily to the action of the venom, and only to a lesser extent to increased compartment pressure (11).

Specific indications for fasciotomy have been established. These are mainly based on clinical evaluation (4). Recent studies support that an increase of intracompartmental pressure up to 30-45 mmHg is an absolute indication for fasciotomy (1,5,7,21). Unfortunately, measurement of intracompartmental pressure is not always possible in a number of medical centers in Greece, so that the diagnosis of compartment syndrome is always based on clinical standards.

According to Parrish (16), 21.2% of all poisonous snake bites involve fingers. The finger can be seen as a very small compartment and because of its

small diameter, the elastic limit of the skin can be rapidly reached. In such cases, a small area of tissue loss may result in functional deficits (13). As that there is no method available to measure the pressure in the finger, the diagnosis of compartment syndrome can only be made on clinical grounds (3). In our series all victims were bitten on the fingers or toes. Although extended black eschars were found in all of them, expectant management was elected. After a mean follow-up of 16 months no functional or cosmetic deficit was recorded in any of our patients.

The morbidity and mortality risks in children have been considered to be higher, as they receive a relatively higher dose of venom because of their smaller size (15,17). If a snake bite is suspected in a child, the identification of a species is of high importance (2). Campbell *et al* (2) in a large series of 114 children snakebites concluded that a conservative approach to the treatment of pediatric pit viper envenomations is best. The lack of studies for snake bites in children in Greece should be stressed.

In summary, *Vipera ammodytes* is a potentially dangerous snake due to the large amount of venom that it injects into the victims ; immediate medical care is required. The majority of the patients with snakebites of fingers or toes by *Vipera ammodytes* can be treated conservatively. Surgery is indicated only in case of compartment syndrome where fasciotomies should be performed without delay after diagnosis.

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