

# Snake Venom Poisoning in Southern California

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APPROXIMATELY 50 rattlesnake bites are recorded each year among the nine million residents of the 11 Southern California counties.<sup>11</sup> The total number of bites by these animals in this area is not known but it would appear to be between 60 and 70 a year. The present fatality rate for recorded cases is 1.5 per cent. This figure substantiates that proposed by Klauber,<sup>1</sup> of probably less than 2 per cent. The rattlesnake is the only naturally occurring venomous snake in Southern California. Of the nine species and subspecies common to the area, the southern Pacific rattlesnake, *Crotalus viridis helleri*, the red diamond rattlesnake, *Crotalus ruber ruber*, and the sidewinder, *Crotalus cerastes laterorepens*, are implicated in the greatest number of injuries to human beings. Bites by nonvenomous reptiles are much more common than bites by rattlesnakes. The differentiation of venomous and nonvenomous snakebites has been reviewed by Pope and Perkins,<sup>10</sup> Klauber<sup>2</sup> and Oliver.<sup>7</sup>

The venom of the rattlesnake causes deleterious changes in the blood cells, defects in blood coagulation, injury to the intimal linings of vessels, damage to the heart muscle, alterations in the respiratory cycle and, to a lesser extent, changes in neuromuscular conduction.\* The approximate lethal dose for man of the venom of the southern Pacific rattlesnake is estimated at 1.0 mg. of dried venom per kilogram of body weight. The average amount of venom milked from ten snakes of this species in this laboratory was 94 mg. when dried. Klauber<sup>2</sup> obtained an average of 112 mg. of dried venom from a total of 880 southern Pacific rattlesnakes, some of which were milked twice. The amount of venom a rattlesnake holds in reserve after an initial bite has been estimated to be between 25 and 75 per cent.<sup>2</sup>

Rattlesnake venom is a complex mixture, chiefly proteins, many of which have enzymatic activity. The lethal effects of the venom are probably due to the nonenzymatic proteins, although the enzymes and enzymatic combinations certainly contribute to the over-all toxicity of the venom. In addition to the separate and combined activities of these substances, and the metabolites formed by their inter-reactions, the envenomated victim may release several auto-

• The annual incidence of rattlesnake bite in Southern California is approximately 1 per 75,000 population. The case fatality rate is 1.5 per cent. The snakes implicated in the greatest number of injuries are the southern Pacific rattlesnake, the red diamond rattlesnake and the sidewinder.

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The most frequently observed symptoms and signs following ophidiiasis in this area are swelling and edema, pain, ecchymosis, swelling of the regional lymph nodes, weakness, sweating, increased body temperature, faintness, and hemorrhagic vesiculations. First aid treatment consists of immobilization of the affected part, application of a constriction band, incision and suction with subsequent local application of ice packs. Treatment in hospital consists of administration of antivenin, antitetanus agent and antibiotic. Transfusions, oxygen and a corticosteroid may be indicated in some cases.

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pharmacologic substances which can render diagnosis and treatment of the victim more difficult.

Not all bites by rattlesnakes provoke symptoms or signs. In five of 22 cases observed by the author, there were no local or systemic manifestations. In three of these the snake's fangs had pierced the skin but had not entered the subcutaneous tissues. In these cases the venom had not been ejected or, if ejected, had not entered the wound. In two patients the fangs had entered the deeper tissues but no evidence of envenomation was apparent. Such incidents of rattlesnake bite without envenomation are well known.<sup>8,9,18</sup> The importance of this factor, and of others affecting the gravity of rattlesnake bites, have been reviewed by Klauber.<sup>3</sup>

## SYMPTOMS AND SIGNS

The symptoms and signs following bites by rattlesnakes in Southern California are summarized in Table 1. Some essential differences were observed in the findings associated with the bites of different species. The bite of the western diamondback rattlesnake, *Crotalus atrox*, tended to cause more pain, edema, ecchymosis, hemorrhagic vesiculations, necrosis, hematemesis and hemolytic anemia than that

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\*References 5, 11, 12, 13, 15, 17.

TABLE 1.—Symptoms and Signs Following Rattlesnake Bites

Symptoms and Signs	Author's Cases	Other Cases*
Fang marks .....	†22/22	†33/33
Swelling and edema .....	17/22	33/33
Pain .....	14/22	30/33
Ecchymosis .....	13/22	26/33
Swelling regional lymph nodes .....	11/12	7/8
Weakness .....	11/17	9/19
Sweating .....	10/17	5/12
Increase body temperature .....	9/17	10/23
Faintness or dizziness .....	8/17	7/14
Hemorrhagic vesiculations .....	8/17	6/16
Nausea or vomiting, or both .....	7/17	6/16
Numbness or tingling of tongue and mouth or scalp .....	7/14	3/10
Leukocytosis .....	6/11	6/14
Decrease in hemoglobin .....	7/17	5/16
Fasciculations .....	5/14	2/6
Blood pressure changes .....	7/17	12/27
Weak pulse .....	7/17	5/17
Increase pulse rate .....	7/17	12/25
Increase blood clotting time .....	7/17	2/6
Respiratory rate changes .....	6/17	6/20
Tingling or numbness of affected part....	6/17	2/12
Respiratory difficulties .....	5/17	4/12
Necrosis .....	4/17	6/16
Hematemesis .....	4/17	2/18
Unconsciousness .....	4/17	5/11
Shock .....	4/17	5/11
Abnormal electrocardiogram .....	3/16	2/16
Convulsions .....	0/17	1/28
Paralysis .....	0/16	0/13

\*Contributed by Doctors C. R. Anderson, A. B. Brower, J. Carlucci, I. A. Fields, E. Gettelman, C. L. Haines, Jr., J. R. Huntsman, E. F. Kline, A. E. Martin, C. J. McCammon, N. P. Papageorges and R. G. Zweifel.

†Number of times symptom or sign was observed in total number of cases.

of the southern Pacific rattlesnake. The latter's bite produced more pronounced changes in consciousness, more profuse weakness and sweating, more severe respiratory difficulties and more tingling or numbness over the affected part and over the tongue, mouth and scalp.

In the author's experience, bites by the sidewinders, *Crotalus cerastes*, have tended to be relatively mild. This may have been due in part to the small size of the snake, as the venom of this species is known to be very toxic.<sup>6</sup> Despite its small size the sidewinder is occasionally the cause of fatal ophidiasis in Southern California. The symptoms and signs following bites by the red diamond rattlesnake are similar to, but less severe than, those seen following bites by the western diamondback rattlesnake. This observation appears to be confirmed by the finding of Kline.<sup>4</sup>

Swelling and edema were the most consistent signs observed following envenomation by rattlesnakes in the 55 cases observed. Swelling usually occurred about the injured area within five minutes after the bite and progressed over the extremity dur-

ing the ensuing one to thirty-six hours. In eight of the author's 22 cases, edema extended beyond the involved extremity.

Pain is a common complaint following rattlesnake bites. The intensity varies with the species of snake and the amount of venom. The most severe pain follows bites by the western diamondback rattlesnake and the red diamond rattlesnake. In three cases of poisoning by the southern Pacific rattlesnake and in one by the sidewinder, the pain was described as minor.

Decided weakness and sweating were consistently associated with poisoning by the southern Pacific rattlesnake. These symptoms were often associated with a rapid, thready, weak pulse and some decrease in systemic arterial pressure and body temperature.

Laboratory findings varied considerably. Mild leukocytosis, spherizing of the red blood cells and defects in coagulation occurred in some cases. In four patients, progressive hemolytic anemia developed, the hemoglobin content eventually falling below 10.0 gm. per 100 cc. Elevated blood urea nitrogen and serum bilirubin were found in two of eight patients in whom tests for these substances were carried out. Hypofibrinogenemia was seen in three patients, hematuria in four, proteinuria in two, and glucosuria in six.

Deaths from rattlesnake bites in Southern California have been attributed to intraperitoneal or retroperitoneal hemorrhage associated with pronounced hemolytic anemia, to acute pulmonary edema associated with respiratory failure or to vascular collapse associated with acute hemolysis.

#### TREATMENT

The treatment and the rationale of the treatment for rattlesnake bites were discussed at length in a previous publication.<sup>11</sup> The suggestions offered in the present communication are based upon the author's clinical experiences, and upon animal experiments in this laboratory.<sup>11,12,13,14</sup>

Immobilization of the affected part with absolute rest for the patient are indicated in all cases. Application of a constriction band directly above the wound site, if the wound is on an extremity, is indicated. It should be released for 90 seconds every 15 minutes. Cruciate or longitudinal incisions one-eighth to one-quarter inch long through the fang marks are advisable if the snake was a large one or the patient is a child. The direction of the strike and the curvature of the fang should be borne in mind when determining the plane of the incision. The depth of fang penetration may be taken as approximately three-quarters of the distance between the two fang marks. Multiple incisions over the involved extremity or in advance of progressive edema are not advised.

Suction should be employed over the incisions during the first hour following the bite unless there is an abnormal amount of bleeding or obvious defect in coagulation. After the first hour the affected part should be placed in an ice bath and the tourniquet removed. Then an hour later ice bags may be substituted for the ice bath and used continuously for one to three days.

None of the foregoing first aid measures should in any way be regarded as substitutes for "the three A's," antivenin, antibiotic and antitoxin,<sup>16</sup> or tetanus toxoid should it be indicated; nor should they be instituted at the possible expense of delaying administration of the antivenin.

The importance of early antivenin therapy is well established.<sup>2,15</sup> The precautions and routes of administration for Antivenin (Crotalidae) Polyvalent® are outlined in the brochure enclosed with each package of the substance. The amount of antivenin used in an individual case depends on the species and size of the snake, the size of the patient, the number of bites, and other factors. For bites by the southern Pacific rattlesnake the author has used three to seven 10 cc. vials in each case. Children bitten by larger rattlesnakes will need at least four vials, possibly eight or nine; and in such cases early administration of the antivenin cannot be overemphasized. Bites by sidewinders require one to four vials. The route for administering the antivenin varies with the individual case. If the patient is not sensitive to the antivenin, the first vial can be divided into three portions and one portion given subcutaneously at various points around the involved extremity above the bite, or in advance of the swelling. Antivenin should never be injected into a toe or finger, however. The second portion is given intramuscularly into a large muscle mass of the involved extremity and the last portion is administered intravenously in a physiological solution. Subsequent doses should be given intramuscularly or intravenously. The anterior thigh is a good area for repeated intramuscular injections.

If the patient is sensitive to horse serum, desensitization should be carried out as indicated in the brochure accompanying the antivenin. Adrenocorticotrophic hormone and cortisone are of value in controlling untoward reactions to horse serum. More than one-fourth of the patients in the author's series of cases had hypersensitivity reactions to the horse serum or to an antibiotic or venom.

Because hemolytic anemia was often observed to follow rattlesnake bite, the author routinely determines the blood type of each patient on admission to hospital. Whole blood transfusions were given in five of the 22 cases. Bleeding and coagulation times should be determined, and hemoglobin determina-

tions, red blood cell counts and urinalysis should be done repeatedly during the entire treatment and the immediate follow-up period.

Use of the appropriate antitetanus agent and antibiotic is advisable. Corticosteroids have been used in many areas of the United States in the treatment of ophidiiasis particularly for bites by copperheads. The author has used them in several cases but has not been able to determine whether they were of value in either reducing the severity of the symptoms or shortening the stay in hospital. It is felt that the physician's reliance should be placed in the antivenin, and that until knowledge of the mechanism of action by which the corticosteroids enter into this complex reaction is more complete, their use should be limited to combating the allergic manifestations provoked by the venom or the horse serum.

Oxygen should be available for patients bitten by a rattlesnake, ready for use if symptoms of systemic involvement develop. Attention should be given to the maintenance of cardiovascular tone. The seriousness of the bite cannot always be determined by the extent of the local manifestations. Serious cardiovascular and respiratory deficits have been observed by the author 20 to 40 hours after the bite, at which time the edema and local tissue changes were minimal.

If a finger, hand or foot has been injured, physical therapy should be begun as soon as the patient's condition permits. Residual contractures are not uncommon. In Southern California the average hospital stay for rattlesnake bites is seven days.

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