REVIEW ARTICLE

Snakebite During Pregnancy: A Literature Review

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Objective.—To review reported bites by venomous snakes in pregnant women.

Methods.—This is a review of Medline/PubMed articles on venomous snakebites occurring during pregnancy reported in the English literature from 1966 to May 2009.

Results.—Two hundred thirteen venomous snakebites were reported in pregnant women. The overall case-fatality rate in the pregnant females was approximately 4%, and the fetal loss rate was approximately 20%.

Conclusions.—Although rare, venomous bites and stings during pregnancy may have a significant adverse effect on the fetus as well as the mother.

Key words: pregnancy, bites, snake, envenomation, antivenom

Introduction

Millions of people are bitten or stung by venomous animals yearly throughout the world.¹ Estimates of snakebites range from 1.2 million to 5.5 million annually with envenomation occurring in 420 000 to 1 841 000 resulting in 20 000 to 94 000 deaths.² Other estimates suggest that more than 150 000 deaths may occur annually.³ Most fatalities occur in developing countries where venomous snakes are plentiful, human populations are dense, and rapid transport and intensive medical treatment facilities are lacking. However, the English literature on snakebite envenomation of pregnant females is limited. In studies from South Africa, India, and Sri Lanka, pregnant women have accounted for 0.4% to 1.8% of hospitalized snakebite victims.⁴ Venomous snakebite in the pregnant female may lead to a poor outcome in both the mother and the fetus. Previous literature reviews found overall fetal deaths ranging from 38% to 43%^{5,6} with maternal deaths of approximately 10% after a venomous snakebite.

Snake venoms are primarily composed of mixtures of proteins and polypeptides with various properties. Many proteins have enzymatic activities, whereas others produce toxic cellular effects. Actions of snake venoms can

be broadly classified as inflammatory, cytotoxic, neurotoxic, and hemotoxic. The composition of venom varies with the species of snake, age of the snake, geographic locality, and time of year.⁷ Other factors influencing the effect of venom on humans include the amount of venom injected and the age and health of the victim.⁸ It is not surprising then that the effect of a venomous snakebite on a pregnant female would differ by species of snake.

Antivenoms, which may be used in the treatment of the envenomed expectant mother, can cause anaphylactic reactions that may have an adverse effect on the mother or fetus.⁴ The fetal death rate has been reported to be up to 55% to 58% in mothers given antivenom.^{5,6} This review updates and discusses maternal and fetal outcomes in pregnant humans that suffered a venomous snakebite.

Materials and methods

A search of the U.S. National Library of Medicine Medline/PubMed database for articles on venomous animal bites and stings and pregnancy worldwide for the years 1966 through May 2009 was conducted (<http://www.ncbi.nih.gov/entrez/query.fcgi>). Terms used in the search included the following: snake bites and pregnancy; bites and stings and pregnancy; envenomation and pregnancy; bites and stings and miscarriage; envenomation and miscarriage; and venom and pregnancy. Articles in the English language or with English abstracts were reviewed.

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The bibliographies of those articles were also reviewed for studies that may not have been indexed in Medline/PubMed. Simple descriptive statistics are used to report the results.

Results

There were 213 cases of snakebite in pregnant females identified in this literature review. As shown in Table 1, at least 87 taxa of snakes involved in bites were reported. In an additional 38 cases, a common name of the snake or general description (eg, viper) was reported, and in 88 cases, the identity of the snake causing the envenomation was unknown or not reported. Due to the variation in venom composition and possible differences in outcome by species of snake, Table 2 shows maternal and fetal outcome when a specific genus or species was provided in the literature. In the majority of cases of fetal death, the snake species was unidentified or not reported.

When reported (99 cases), victims ranged in age from 14 to 46 years with an average age of 26 years. In most cases, no information on race was reported. The gestational age of the mother (in weeks) at time of envenomation was reported in 112 cases. The gestational age averaged 22.1 weeks with a range of 6 to 37 weeks at time of bite. In an additional 87 cases, only the trimester of pregnancy was reported: 29 in the first trimester, 35 in the second trimester, and 23 in the third trimester.

Of the envenomations, there were 9 maternal deaths (9 of 213) reported. The case-fatality rate was approximately 4.2%. No maternal deaths from a native U.S. species were reported. There were 41 deaths of the fetus or neonate reported. The vast majority were in utero fetal deaths. The deaths in the neonates occurred from 30 minutes to 8 days after birth. The case-fatality rate was approximately 19.2%.

In most cases, there is no mention of the specific details underlying the cause of death or autopsy reports in either the mother or fetus. However, abruptio placentae were reported to have occurred in 8 cases, with fetal deaths noted in 6 of these cases. Malformations were reported in 3 cases: a case of hydrocephalus and polydactyly; a case of dilatation of the cerebral ventricles and intracranial hemorrhage; and a case of hydrocephalus with nonspecified multiple malformations. Where reported (26 cases), in the cases of fetal death the average maternal age was 27.4 years compared with 25 years in cases (67 cases) with no fetal deaths. The average gestational age (28 cases) at time of fetal death was 20.2 weeks compared with 22.6 weeks in cases (67 cases) without fetal death. Eleven fetal deaths occurred during the first trimester, 7 during the second trimester, and 10 during the third trimester.

Ninety-six mothers received antivenom treatment. Of these cases, 2 (2.1%) mothers died. Twenty-nine (30.2%) fetuses/neonates died from mothers that had received antivenom. In 106 cases where no antivenom was reported being given or unknown if given to the mother, 7 (6.6%) mothers and 12 (11.3%) fetal/neonatal deaths were reported. There was 1 case of serum sickness reported in a 46-year-old mother that received antivenom at 14 weeks gestation, but she delivered a healthy child at term.

Discussion

Few reviews of pregnant women bitten by snakes have been published. Dunnihoo et al⁵ reviewed the literature and found 50 cases, but details were only available for 30 of the victims. Pantanowitz and Guidozzi⁹ reported 12 additional cases, 9 found in the literature and 3 cases reported by personal communication (R.S.M. Blaylock, 1996). Following these two literature reviews, Seneviratne et al⁴ reported snakebites in 39 pregnant women treated at 2 medical centers in Sri Lanka from 1997 to 1999 at one hospital and from 1996 to 2001 at another. Langley⁶ reviewed the literature from 1996 to 2002 and noted 85 cases had been reported in the English literature with 8 maternal deaths and 32 fetal/infant deaths. In a recent report, Seifert et al¹⁰ briefly discuss 65 cases of snake envenomations during pregnancy reported to the American Association of Poison Control Centers from 2001 to 2005.

From a review of the limited literature, abortions and deaths in fetuses/infants after a mother has been bitten by a venomous snake are not unusual. Seneviratne et al⁴ reported that nearly 30% of the envenomated pregnant mothers had a spontaneous abortion. Malz¹¹ reported that 3 of 14 (21%) snakebites resulted in abortion or infant death. Dunnihoo et al⁵ noted that of 30 reports with some detailed information available, 6 spontaneous abortions, 7 fetal deaths, and 1 elective abortion occurred, a 43% fetal loss occurrence (excluding the elective abortion). Reid et al¹² reported 1 of 5 (20%) women aborted after a venomous bite. Dao et al¹³ reported 4 snakebites in pregnant women leading to fetal death or abortion in 3 of them. One mother was in her fifth month of pregnancy and aborted 2 days later, and another was at term when snakebite resulted in death of the fetus.

The average age of the mothers where age was reported was 26 years. The mean gestational age was 22.1 weeks. The average age of the mothers that aborted or had fetal demise was slightly older than that of mothers that did not have fetal demise. The average length of gestation at the time of fetal demise or abortion was 20.2 weeks. Whereas some studies report the risk of poor fetal

Table 1. Snakebite reported during pregnancy

Study (first author)	No. bitten	Snake	No. receiving antivenom	Outcome	
				Mother	Fetus/infant
Singh ³¹	1	<i>Echis carinatus</i>	NR	Died	Died (74 hours after bite)
Reid ¹²	5	<i>Calloselasma rhodostoma</i>	NR	5 alive	1 aborted 4 alive
Bhat ³²	3	Viper	3 ^a	3 alive	3 aborted
Fauveau ³³	3	Species not reported	NR	3 died	3 died
Chugh ³⁴	1	Viper	NR	Died	Died
Entman ¹⁵	1	<i>Agkistrodon contortrix</i>	1	Alive	Died 4 days after birth (6 weeks after bite)
Parrish ¹⁴	4	2 <i>Agkistrodon contortrix</i>	—	4 alive	1 aborted (24 hours after bite)
		1 Rattlesnake	1		3 alive
		1 Unidentified	1		
McNally ³⁵	1	Adder	NR	Alive	Alive (premature)
Sutherland ¹⁶	1	<i>Pseudonaja</i> sp.	1	Died ^b	Died
Zugaib ¹⁷	1	<i>Bothrops jaracaca</i>	1	Alive	Died (abruptio placentae)
Malz ¹¹	14	1 <i>Vipera palaestinae</i>	1	14 alive	10 alive
		4 Viper	3		2 aborted
		9 Unidentified	4		1 elective abortion 1 died ^c
Dumavibhat ³⁶	1	<i>Trimeresurus</i> sp.	1	Alive	Alive
Dunniho ⁵	2	1 <i>Agkistrodon contortrix</i>	—	2 alive	2 alive
		1 Unidentified			
James ¹⁸	4	2 <i>Naja</i> sp.	3	3 alive	3 alive
		2 Viper		1 died	1 died
Dao ¹³	4	Unidentified	—	3 alive	3 died
				1 died	1 unknown (mother lost to follow-up)
Seneviratne ⁴	39	2 <i>Bungarus ceylonicus</i>	2	39 alive	11 aborted
		9 <i>Daboia russelii russelii</i>	7		28 alive (1 malformed)
		14 <i>Hypnale hypnale</i>	—		
		14 Unidentified	8		
D'Ambruoso ³⁷	1	Puff adder	—	Died	Died 8 days after birth, unknown cause
Lurie ²⁸	1	<i>Vipera palaestinae</i>	1	Alive ^d	Alive
Otero ³⁸	1	<i>Bothrops asper</i>	1	Alive	Died (abruptio placentae)
Duru ³⁹	1	<i>Vipera lebetina obtusa</i>	1	Alive	Alive
Barry ³⁰	9	Species not reported	9	9 alive	9 alive
Sarkar ⁴⁰	11	Viperidae	11	11 alive	10 alive, 1 fetal death (abruptio placentae in 3 cases including the death)
Chen ⁴¹	3	<i>Trimeresurus stejnegeri</i>	2	3 alive	3 alive
Nasu ⁴²	1	<i>Agkistrodon halys blomhoffi</i>	—	Alive	Fetal death
Hanprasertpong ⁴³	1	<i>Calloselasma rhodostoma</i>	1	Alive	Fetal death (abruption placentae)
Habib ⁴⁴	11	10 <i>Echis ocellatus</i>	10	10 alive	1 fetal death 9 presumed alive
		1 <i>Naja nigricollis</i>	NR		1 unknown (<i>Naja</i>)
Adam ⁴⁵	1	Species not reported	1	Alive	Fetal death (abruptio placentae)
Adam ⁴⁶	1	Species not reported	1	Alive	Died 30 minutes after birth
Chang ⁴⁷	1	<i>Agkistrodon contortrix</i>	—	Alive	Alive
Kravitz ⁴⁸	1	<i>Agkistrodon contortrix</i>	1	Alive	Alive
Sebe ⁴⁹	3	2 <i>Vipera lebetina obtusa</i>	3	3 alive	3 alive
		1 <i>Vipera ammodytes meridionalis</i>			

Table 1. Continued

Study (first author)	No. bitten	Snake	No. receiving antivenom	Outcome	
				Mother	Fetus/infant
Pardal ⁵⁰	8	Species not reported	NR	8 alive	1 fetal death (abruptio placentae) 7 alive
Mullen ⁵¹	1	Rattlesnake	1	Alive	Alive at discharge from hospital
Seifert ¹⁰	65 ^e	4 Rattlesnakes	4	65 alive	65 presumed alive but limited follow-up data
		5 <i>Agkistrodon piscivorus</i>	1		
		19 <i>Agkistrodon contortrix</i>	—		
		37 Species not reported	6		
LaMonica ⁵²	7 ^f	7 Rattlesnakes	4	7 alive	7 presumed alive but limited follow-up data
Total alive	213	88 unidentified and/or not reported	96	203 alive 9 died 1 unknown	98 alive 41 died 2 unknown 72 presumed alive but limited follow-up

NR, not reported or no information.

^a Presumed received antivenom.

^b Death attributed to supine hypotensive syndrome.

^c Malformations and died a few days after birth.

^d Mother developed serum sickness from antivenom.

^e May include cases reported by Barry from 2001 to 2005.

^f Reports from 2006 and 2007 only, 4 additional rattlesnake cases reported in Seifert.

outcomes to be more common if envenomed in the first trimester,⁴ this review found nearly the same number of fetal deaths occurred in pregnant females bitten in either the first or third trimesters. However, in many cases the gestational age was not reported, so it is not possible to state whether the length of gestation at time of envenomation is a risk factor.

Of the 213 cases identified, limited information on the type of envenomating snake was provided in 125 cases; however, an exact identification was provided in much fewer. Without the correct identification of the species of snake, it is unclear, but likely, that certain species are more likely to cause adverse harm to the mother and fetus. For example, in the report by Seifert et al, moderate or major adverse effects were reported in 70% of rattlesnake bites and were the only snake group coded with major adverse outcomes.¹⁰ As seen in Table 2, almost half of the victims bitten by a Russell's viper had fetal demise. However, how soon the patient is seen and treated after the snakebite may have a more significant impact on maternal and/or fetal outcome than the species of snake involved in the envenomation. There were no maternal deaths reported from envenomation by U.S. native species and only 2 fetal deaths reported.^{10,14,15} This may reflect more rapid access to health care and availability of antivenom in the United States or possibly less venomous species.

Several mechanisms have been proposed to explain fetal deaths or abortions after snakebite including fetal anoxia associated with maternal shock after envenomation, direct effect of the venom on the fetus, hemorrhages into the placenta and uterine wall causing abruptio placentae, premature uterine contractions initiated by the venom, pyrexia and cytokine release after tissue damage, maternal hemorrhage with acute fetal anemia causing in utero fetal death, supine hypotension syndrome, and potential maternal anaphylaxis to antivenom.^{9,13-17} Eight cases of abruptio placentae were found in this review. It has been reported that in a few cases, mothers had systemic envenomation without signs of local envenomation.¹⁸

Venom from various species of snakes has been shown to cause uterine contractions in animals and in isolated uterine tissue. Venoms may act directly on uterine muscle or may act indirectly by causing the release of or potentiating the effect of bradykinins on uterine muscle.¹⁹⁻²³ Venom components may exert a direct toxic effect on parts of the placenta.²⁴ Some components may cross the placenta and adversely affect the fetus in the absence of, or before, seriously affecting the mother.¹⁸

Malformations were noted in 3 cases. Senevirante et al⁴ described a woman bitten by a Russell's viper during her 16th week of pregnancy who later gave birth to a child with hydrocephalus and polydactyly. Malz¹¹ re-

Table 2. Taxa of snake involved in envenomation during pregnancy

<i>Snake</i>	<i>No. of cases reported</i>	<i>No. of cases where antivenom used</i>	<i>Maternal outcome</i>	<i>Fetal outcome</i>
<i>Agkistrodon contortrix</i>	25	2	25 alive	1 died (mother had adverse reaction to antivenom), 24 alive
<i>Agkistrodon piscivorus</i>	5	1	5 alive	5 alive
<i>Echis carinatus</i>	1	Unknown	Died	Died
<i>Echis ocellatus</i>	10	10	10 alive	10 alive
<i>Psuedonaja</i> sp.	1	1	Died	Died
<i>Bothrops jarcarca</i>	1	1	Alive	Died
<i>Bothrops asper</i>	1	1	Alive	Died
<i>Vipera lebetina obtuse</i>	3	3	3 alive	3 alive
<i>Vipera ammodytes meridionalis</i>	1	1	Alive	Alive
<i>Trimeresurus stejnegeri</i>	3	2	3 alive	3 alive
<i>Agkistrodon halys blomhoffi</i>	1	0	Alive	Died
<i>Calloselasma rhodostoma</i>	6	1 yes 5 unknown	6 alive	2 died 4 alive
<i>Vipera palaestinae</i>	2	2	2 alive	2 alive
<i>Trimeresurus</i> sp. (Green pit viper)	1	1	Alive	Alive
<i>Naja nigricollis</i>	1	Not reported	Not reported	Not reported
<i>Bungarus ceylonicus</i>	2	2	2 alive	1 alive 1 died
<i>Daboia russelii russelii</i>	9	7	9 alive	4 died 5 alive
<i>Hypnale hypnale</i>	14	0	14 alive	13 alive 1 died

ported a woman bitten by a viper in her 12th week that 6 months later delivered a child with multiple malformations and hydrocephalus who died a few days later. Entman and Moise¹⁵ report a woman with copperhead envenomation and apparent anaphylaxis to antivenom therapy in her 28th week of gestation. She was treated with epinephrine, isoproterenol, methylprednisolone, and diphenhydramine. Six weeks later, she had spontaneous rupture of the membranes and delivered an infant with low Apgar scores. Ultrasound of the baby's head disclosed dilatation of the ventricles and echogenic changes consistent with intracranial hemorrhage. The infant died 4 days later. Though the cause-effect relationship between envenomation and malformations in these 3 cases is unknown, it is possible that snake venom can cause embryotoxic and teratogenic effects. The venom of *Vipera aspis* has been shown to cause congenital anomalies in the form of cleft palate and facial deformities in pregnant mice.²⁵ *Naja nigricollis* venom injected into pregnant mice caused hepatic and myocardial damage as well as pulmonary vascular congestion and extravasated blood in the intestinal lumen of the fetuses.²⁶ Arvin, the active defibrinating fraction of the Malayan pit viper, *Calloselasma rhodostoma*, caused high rates of fetal

death and resorption during early organogenesis in pregnant rabbits. Abortions and hemorrhage occurred when arvin was given during days 11 to 15 of gestation.²⁷ Arvin administered to pregnant mice at partial and complete defibrinating doses resulted in many embryonic deaths.

Antivenom is the required treatment for severe snakebite envenomations. Of the 213 cases, 96 mothers received antivenom. Two mothers that received antivenom died. The effect of antivenom on the fetus remains unclear. Senevirante et al⁴ reported 10 abortions and 1 malformation in 11 of 17 (64.7 %) patients treated with antivenom. However, they did not find the administration of antivenom to be an independent risk factor for adverse fetal outcome. Poor fetal outcome was associated with symptoms of systemic envenomation, and the period of amenorrhea was 18 weeks or less in all cases where the mother aborted. Senevirante et al⁴ noted that in many instances, details on the type of antivenom administered or the circumstances of treatment was lacking. In this updated literature review, of 96 women that received antivenom, 29 fetal deaths occurred. Only 2 (2.1%) maternal deaths have been reported in mothers that received antivenom. This is in contrast with 7 (6.6%) maternal deaths in cases that did not receive antivenom. Whereas

acute adverse effects from the use of antivenom have been reported in the mothers,² only 1 case of serum sickness has been reported in a pregnant person.²⁸ From the limited number of cases reported, it appears likely that antivenom is effective in preventing maternal deaths, that adverse reactions in the mother can be readily managed, and that delayed serum sickness is rare. Although the fetal death rate was higher in cases where the mother received antivenom (30.2% vs 11.3%), this may reflect more significant envenomation, and the mother (and fetus) may have been more likely to die if antivenom was withheld. While the safety of antivenom in pregnancy is unclear, the risks of withholding likely outweigh the risks of administering in correct clinical scenarios. If the mother develops an acute anaphylactic reaction to the antivenom, ephedrine or phenylephrine may be preferred over epinephrine as epinephrine may adversely affect placental blood flow properties.^{15,29}

Limitations of this study include a retrospective review of case reports of variable quality and likely underestimates the incidence of snakebites in pregnancy, as nonvenomous snakebites or dry bites or venomous snakebites causing minimal symptoms are often not reported. There may also be an overestimate of the severity of snakebite in pregnancy as the more sensational cases or ones that lead to death are more likely to be published. Many reports also do not identify the species of snake or used generic terms such as *viper* to describe the snake. There also may be a few cases (<9) reported by Barry et al³⁰ that were also reported by Seifert et al¹⁰ resulting in a slight overcount of cases as their time frames overlap. Prospective studies should be conducted to obtain better epidemiologic data on snakebites in pregnancy and include information on maternal age, gestational age, underlying medical conditions, species of snake involved, and circumstances surrounding the bite such as snake provoked, use of alcohol, and occupational activity. Data on specific treatment provided and maternal and fetal outcome including autopsy reports should be collected. Data on specific species of snake involved in the envenomation may allow better predictions on maternal and fetal outcomes and the need for more aggressive early interventions.

Conclusion

Venomous animal bites and stings during pregnancy are rarely reported. Unfortunately, among previously documented cases of snakebite during pregnancy, the occurrences of fetal and maternal deaths were high (38% to 43% and 10%, respectively). However, the more recent literature seems to show an improvement in both the maternal and the fetal outcomes. With inclusion of the

most recent case reports, the overall rate of fetal loss is now around 20% and maternal case-fatality rate is about 4% to 5%. Envenomations during pregnancy should be reported so that additional information on medical management and fetal outcomes can be evaluated. More animal studies and human investigations are needed to evaluate the effect of snake antivenom on pregnant mothers, embryos, and fetuses.

References

1. Kasturiratne A, Wickremasinghe Ar, de Silva N, et al. The global burden of snakebite: a literature analysis and modelling based on regional estimates of envenoming and deaths. *PLOS Med*. 2008;5:1591–1604.
2. White J. Bites and stings from venomous animals: a global overview. *Ther Drug Monit*. 2000;22:65–68.
3. Chippaux JP. Snake-bites: appraisal of the global situation. *Bull World Health Org*. 1998;176:515–524.
4. Seneviratne SL, de Silva CE, Fonseka MMD, Pathmeswaran A, Gunatilake SB, de Silva HJ. Envenoming due to snake bite during pregnancy. *Trans R Soc Trop Med Hyg*. 2002;96:272–274.
5. Dunnihoo DR, Rush BM, Wise RB, Brooks GG, Otterson WN. Snake bite poisoning in pregnancy. A review of the literature. *J Reprod Med*. 1992;37:653–658.
6. Langley R. A review of venomous animal bites and stings in pregnant patients. *Wilderness Environ Med*. 2004;15:207–215.
7. Gold B, Dart R, Barish R. Bites of venomous snakes. *N Eng J Med*. 2002;345:347–356.
8. David P. Principal actions of venoms and their symptoms. In: Bauchot R, ed. *Snakes: A Natural History*. New York: Sterling Publishing Co; 2006:208–209.
9. Pantanowitz L, Guidozzi F. Management of snake and spider bite in pregnancy. *Obstet Gynecol Surv*. 1996;51:615–620.
10. Seifert SA, Boyer LV, Benson BE, Rogers JJ. AAPCC database characterization of native U.S. venomous snake exposures, 2001–2005. *Clin Toxicol*. 2009;47:327–335.
11. Malz S. Snake-bite in pregnancy. *J Obstet Gynaecol Br Commonw* 1967;74:935–937.
12. Reid HA, Chan KE, Thean PC. Prolonged coagulation defect (defibrination syndrome) in Malayan viper bite. *Lancet*. 1963;1:621.
13. Dao B, Da E, Koalaga AP, Bambara M, Bazie AJ. Snake bite during pregnancy. *Med Trop (Mars)*. 1997;57:100–101.
14. Parrish HM, Khan MS. Snakebite during pregnancy. Report of four cases. *Obstet Gynecol*. 1966;27:468–471.
15. Entman SS, Moise JJ. Anaphylaxis in pregnancy. *South Med J*. 1984;77:402.
16. Sutherland SK, Duncan AW, Tibballs J. Death from a snakebite associated with the supine hypotensive syndrome of pregnancy. *Med J Aust*. 1982;2:238–239.
17. Zugaib M, de Barros ACS, Bittar RE, Burdmann E de A, Neme B. Abruptio placentae following snake bite. *Am J Obstet Gynecol*. 1985;151:754–755.

18. James RF. Snakebite in pregnancy. *Lancet*. 1985;2:731.
19. Komori Y, Nikai T, Sugihara H. Biochemical and physiological studies on a kallikrein-like enzyme from the venom of *Crotalus viridis viridis* (prairie rattlesnake). *Biochim Biophys Acta*. 1988;967:92–102.
20. Mori N, Sugihara H. Kallikrein-like enzyme from *Crotalus ruber ruber* (red rattlesnake) venom. *Int J Biochem*. 1988;20:1425–1433.
21. Wangai J, Thairu K, Telang BV. Skeletal neuromuscular and smooth muscle effects of whole venom of the green mamba, *Dendroaspis angusticeps*-I. *Indian J Physiol Pharmacol*. 1981;25:176–179.
22. Andriao-Escarso SH, Soares AM, Rodrigues VM, et al. Isolation and characterization of an arginine ester hydrolase from *Bothrops jararacussu* venom which induces contractions of the isolated rat uterus. *Biochem Mol Biol Int*. 1999;47:699–706.
23. Gomes A, De P, Dasgupta SC. Occurrence of a unique protein toxin from the Indian King Cobra (*Ophiophagus hannah*) venom. *Toxicon*. 2001;39:363–370.
24. Nawar NN, Mohamed AH, Adieb N, Emad M. The effect of maternal *Naja nigricollis* envenomation on the placenta. An experimental study. *Biol Struct Morphog*. 1989;2:13–17.
25. Gabriel-Robez O, Clavert J. Teratogenic and lethal properties of the various fractions of venom of the viper, *Vipera aspis*. *Acta Anat* (Basel). 1980;108:226–229.
26. Mohamed AH, Nawar NNY, Hanna MM. Some effects of *Naja nigricollis* envenomation on developing fetal tissue. *Toxicon*. 1974;12:477–480.
27. Penn GB, Ross JW, Ashford A. The effects of arvin on pregnancy in the mouse and the rabbit. *Toxicol Appl Pharmacol*. 1971;20:460–473.
28. Lurie Y, Bentur Y. *Vipera palaestinae* bite and serum sickness during pregnancy. *J Emerg Med*. (In press).
29. Ngan Kee WD, Khaw KS. Vasopressors in obstetrics: what should we be using? *Curr Opin Anaesthesiol*. 2006;19:238–243.
30. Barry J, Chin E, Borys D. Snake envenomation in pregnant patients during the Fab antibody fragment antivenom era. *Clin Toxicol*. 2008;46:597.
31. Singh CSAS. A fatal case of snake bite (*Echis carinatus*) during pregnancy. *Ind Med Gaz*. 1925;60:471.
32. Bhat RN. Viperine snakebite poisoning in Jammu. *J Indian Med Assoc*. 1974;63:383–392.
33. Fauveau V, Blanchet T. Deaths from injuries and induced abortion among rural Bangladeshi women. *Soc Sci Med*. 1989;29:1121–1127.
34. Chugh KS, Singhal PC, Kher VK, et al. Spectrum of acute cortical necrosis in Indian patients. *Am J Med*. 1983;286:10–20.
35. McNally SL, Reitz CJ. Victims of snakebite. A 5-year study at Shongwe Hospital, Kangwane, 1978–1982. *S Afr Med J*. 1987;72:855–860.
36. Dumavibhat B, Visudhiphan S, Malasit P. Severe cases of green pit viper snake venom poisoning. *J Med Assoc Thai*. 1989;72:593–596.
37. D'Ambruoso L, Byass P, Ouedraogo M. Maternal death due to postpartum hemorrhage after snakebite. *Int J Gynaecol Obstet*. 2008;102:71.
38. Otero R, Gutierrez J, Mesa MB, et al. Complications of *Bothrops*, *Porthidium*, and *Bothriechis* snakebites in Colombia. A clinical and epidemiological study of 39 cases attended in a university hospital. *Toxicon*. 2002;40:1107–1114.
39. Duru M, Helvacı M, Peker E, Dolapcioglu K, Kaya E. Reptile bite in pregnancy. *Hum Exp Toxicol*. 2008;27:931–932.
40. Sarkar S, Bhattacharya P, Paswan A. Snakebite in pregnancy: preliminary study. *Br J Anaesth* 2008;101:128–129.
41. Chen YC, Chen MH, Yang CC, Chen YW, Wang AL, Huang CI. *Trimeresurus stejnegeri* envenoming during pregnancy. *Am J Trop Med Hyg*. 2007;77:847–849.
42. Nasu K, Ueda T, Miyakawa I. Intrauterine death caused by pit viper venom poisoning in early pregnancy. *Gynecol Obstet Invest*. 2004;57:114–116.
43. Hanprasertpong J, Hanprasertpong T. Abruptio placentae and fetal death following a Malayan pit viper bite. *J Obstet Gynaecol Res*. 2008;34:258–261.
44. Habib A, Abubakar S, Abubakar I, et al. Envenoming after carpet viper (*Echis ocellatus*) bite during pregnancy: timely use of effective antivenom improves maternal and foetal outcomes. *Trop Med Int Health*. 2008;13:1–4.
45. Adam I, Geraıs AS. Abruptio placentae following snake bite in a Sudanese woman. *Saud Med J*. 2005;26:686–687.
46. Adam GK, Hussein SM, Adam I. Renal failure and neonatal death following snakebite during pregnancy. A case report. *J Venom Anim Toxins Incl Trop Dis*. 2006;12:653–656.
47. Chang C, Jaynes C, Fernandez M, Hougén S. Pit viper envenomation in pregnancy: a case report and literature review. *J Emerg Med*. 2006;30:167–169.
48. Kravitz J, Gerardo C. Copperhead snakebite treated with Crotalidae polyvalent immune Fab (Ovine) antivenom in third trimester pregnancy. *Clin Toxicol*. 2006;44:353–354.
49. Sebe A, Satar S, Acikalin A. Snakebite during pregnancy. *Hum Exp Toxicol*. 2005;24:341–345.
50. Pardal P, Mazzeo T, Pinheiro A. Snakebite in pregnancy: a preliminary study. *J Venom Anim Toxins*. 1997;3:280–286.
51. Mullen W, Dart R, Loson K. Use of CroFab in an eight month pregnant woman. *Clin Toxicol*. 2002;40:675.
52. LaMonica GE, Seifert SA, Rayburn WF. Rattlesnake bite in pregnant women. *J Med Toxicol*. (In press).