BEE STINGS

Toxic Effects and Allergy

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"The first recorded fatality from stinging insect hypersensitivity probably occurred in Egypt in 2621 BC. The victim was King Menes, the first king of the first Dynasty, founder of the city of Memphis, and diverter of the Nile. An account of his death is found on the walls of his tomb. There is some ambiguity in the translation of the hieroglyphics as the symbol for a wasp is very similar to that for hippopotamus. However, as no hippopotamus stings have been recorded since that time, the former translation seems secure!"

Dr David Sutherland, Newcastle Immunologist (1)

There is widespread fear of bees in the community. This not only because bee stings hurt, but because many people believe that they are "allergic" to them when they swell up after a sting. The fact is that true allergy is relatively rare, estimated as 0.3—0.5 % of the population (2). Nevertheless, it is a serious problem, accounting for approximately one death per year in Australia (3) and 40 per year in the USA (2).

It is the purpose of this paper to discuss the two types of effects of bee stings; those due to the toxic or poisonous properties of bee venom itself, (the "normal" response to a sting), and those due to allergy to the venom (the "abnormal" response, allergy or hypersensitivity).

Fatality solely due to the toxic effects of the venom itself is extremely rare, the estimated lethal dose being estimated as 192 stings per kilogram body weight, which translates as approximately 1400 stings for the average male and 1100 for a female. However, death has been recorded after as few as 50 stings. For what it is worth, 500 bee stings equate to a rattle snake bite! (2).

In contrast, in a person truly allergic to bee venom a single sting is potentially fatal.

So, what is the difference, why are bee stings so dangerous to some people while relatively harmless to the vast majority?

What is "allergy"?

It is a word of Greek origin meaning “other work”, or, in this context, “other reaction”. The words "hypersensitivity reaction" have a similar meaning, while "anaphylaxis" is used to describe the most extreme form of allergic or hypersensitivity response.

When foreign protein substances are taken into the body, either by mouth or injection, a defence reaction is set up and "antibodies" are formed. These are our own proteins designed to lock on to the specific foreign protein and neutralise it when the body is next exposed to it. This is the basis of immunisation, a wonderful medical tool which has eliminated smallpox from the world. It is the "normal" response which is responsible for the experienced beekeeper’s well known tolerance or "immunity" to bee stings. These "good" antibodies are known as Immunoglobulin G, or IgG.
In the “allergic” person, the response to the foreign protein is different. Instead of IgG being produced, another antibody, IgE results. It adheres to some blood and tissue white cells, awaiting further exposure to the offending protein, called an “antigen”. When this eventuates, the antigen reacts with the IgE antibody and the white cell to produce a toxic and dangerous substance called “histamine” along with other substances which produce the physiological effects we know as an “allergic” response.

Thus, the first exposure to the offending protein, in our context one or more of the proteins in bee venom, may produce no more than the “normal” reaction to the toxin itself, but subsequent stings result in increasingly severe reaction, a crescendo effect due to the production of more and more IgE and histamine. In the extreme, or anaphylactic reaction, the bronchial tubes go into spasm, narrow the airways causing difficulty breathing, the blood pressure falls, the victim is in shock and can die.

Allergy is, however, notoriously unpredictable. It is not unknown for such an anaphylactic reaction to result from the first apparent exposure to the antigen. In contrast, “decrescendo” or allergic reactions of decreasing severity have been recorded, (1, 2, 4) and even previously immune beekeepers have been known to develop allergic symptoms much later (5).

One may well ask why do some people develop “good” IgG and others a predominance of “bad” IgE? This is unknown. It is known that some protein antigens are very prone to set up the production of IgE. There are several of these “highly antigenic” proteins in bee venom. It is also recorded that people with asthma or eczema, conditions involving the immune system, are more at risk of developing allergy to bee venom (6, 7).

The members of the families of beekeepers have a higher incidence of allergy than the rest of the population (8). It is suggested that this is due to contact with repeated small amounts of bee products from body contact and clothing which “sensitise” the person by provoking the production of IgE.

What is in bee venom?
It is a complex mixture of chemical substances including enzymes, peptides (protein derivatives), highly active amines including histamine itself and (nor)adrenaline. The enzymes hyaluronidase, phospholipase and acid phosphatase are highly allergenic.

What is the “normal” reaction to bee venom itself?
It hurts! One needs only to see a child stung for the first time to appreciate how much it can hurt. The immediate vicinity of the sting then swells over the next few hours, and the softer the tissue at the site of the sting the more it swells, eg forearms, face and (God forbid) the genitals. This may last several days, turn a dull red and become quite itchy.

Provided the swelling is confined to the vicinity of the sting and is relatively short lived, this is not an allergic reaction.

What is an Allergic Reaction?
There is a wide range of effects, local and generalised, and these have been artificially categorised into four grades.
Grade I is a local response like the “normal” effect of the sting, but the swelling is more extensive, “angry”, very itchy and lasts much longer.
Grade II consists of the same local effects plus a generalised reaction with swelling beyond the site of the sting. A whole limb may swell, or the face and lips and eyelids swell after a sting on the foot. The may be a generalised rash, often “urticarial” with itchy wheals.
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Grade III is the same as grade II with the addition of difficult breathing due to spasm of the bronchial tubes.
Grade IV is all of the above plus a dangerous fall in blood pressure (shock), collapse and even death.

Beekeeper’s Immunity
Every beekeeper knows that stings hurt less with repeated exposure. Some even try to pretend that they don’t hurt at all. The truth is probably nearer to what Laurence of Arabia is supposed to have said “the important thing is not minding that it hurts”! Certainly local reactions are much less severe and more short lived. This is due to the “good” IgG antibodies neutralising some of the toxic contents of the venom. Tests on beekeepers show high levels of serum IgG, but two out of three also have higher than normal levels of IgE which is capable of producing adverse effects. Presumably it is the balance between levels of protecting IgG and potentially offending IgE which determine the outcome of a sting. This explains two observations, firstly why some beekeepers note greater reaction to stings after a long period without exposure, and secondly why apparently “immune” beekeepers can develop symptoms of allergy later in life.
There is anecdotal (unproven or hearsay) evidence, quoted in the Australian Beekeeper in 1994 that taking non-steroidal anti-inflammatory arthritis drugs may diminish this established immunity. This is of particular interest because there is also anecdotal evidence, unconfirmed by scientific study, that beestings have a beneficial effect on arthritis. The author has in the past tried to encourage his arthritis suffering wife to get stung, but for some strange reason she has always refused. In view of the information quoted above that there is a significant incidence of covert allergy in the families of beekeepers, it may be that the wife is smarter than the husband.

Treatment of Beestings
The "normal" effects of a sting need no special treatment. (However, this is like the definition of a minor illness or operation—one that somebody else has!). Every beekeeper knows that the sting should be flicked out promptly as the venom sac goes on injecting after the unfortunate bee is dismembered. It has been stated that you have to be quick, most of it is in within two seconds! Itching may be helped by topical applications such as calamine lotion or by taking an antihistamine. Alkaline applications or topical alum (contained in “Stingose”) may be used.
neutralises the effects of the histamine which is the cause of the trouble. This is a powerful and dangerous drug, the dose is critical, and its use requires medical supervision. For those who know they are at risk, a self-injection kit is available and can be used after suitable instruction, and adrenaline is now available as a metered dose aerosol.

Further doses of adrenaline may be required, as well as ventilatory support and intravenous therapy to maintain blood pressure. This clearly means removal to hospital, if possible by skilled paramedics who are competent to administer appropriate treatment en route.

It is reassuring to reiterate that such severe reactions are rare.

Desensitisation

It is possible to “desensitise” an allergic person but it requires a prolonged course of injections supervised by a skilled professional immunologist. In earlier years whole body bee extracts were used, but currently bee venom itself is found to be more effective. It is collected by mounting at a hive entrance an electrical device with an underlying perforated membrane, the holes of which just admit the bee sting. An electric shock stimulates the bee to sting the membrane, the venom is collected beneath it, and the bee survives because the sting can be withdrawn from the hole in the membrane.

This process of desensitisation aims to decrease the levels of IgE, and increase IgG. The method consists of giving at first tiny doses of the venom by injection, followed by slowly increasing doses, always with means of resuscitation at hand lest an unexpected reaction occurs. Side effects have been reported to be as high as 41%, though many of these are minor. It may take many months, and maintenance doses may be required for some years.

Thus desensitisation is time consuming, and is associated with discomfort and significant risk. It is contemplated only after serious general allergic symptoms, not local reactions. Only expert professionals are competent to advise upon it and administer the treatment.

Fortunately, however, desensitisation works. For protection against life threatening anaphylaxis, it is 100% effective, and only one in 20 people have minor local reactions (9).

SUMMARY

All that swells is not allergy. Local pain and swelling are the normal response to the injection of bee venom. In a non-allergic person, many stings can be sustained without threat to life, and repeated stings produce a tolerance or immunity resulting in a gradual decrease in reaction severity. This is due to the body’s production of appropriate antibody which neutralises the toxin subsequently injected.

In a person allergic to bee venom, other antibodies are produced in response to stings, antibodies which do not protect but rather provoke the internal release of an even more dangerous substance, histamine. In such people, there is likely to be an increasingly severe reaction to subsequent stings, ranging from extreme local pain and swelling, to rashes, difficulty breathing, fall in blood pressure, shock and death.

There is no antidote to bee venom. The immediate treatment of a severe allergic reaction is the injection of adrenaline, but more drastic measures may be required. Severely allergic people must avoid bee stings or undergo desensitisation therapy.

REFERENCES
1. Sutherland, D: Management Options in Stinging Insect Allergies, Patient Management October 1986, 67-79
2. Sutherland, D: Monograph on Insect Allergy in American Academy of Allergy and Immunology, Levine and Locke, 3rd Ed. 1995.