

Surgical Removal of Venom Glands in Australian Elapid Snakes ... The creation of venomoids.

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ABSTRACT

This is the first report of the surgical removal of venom glands from Australian snakes by going through the roof of the mouth as opposed to via external excision.

Other than a previous case more than 20 years ago involving the removal of venom glands by cutting the side of a snake's head (see Millar 1976), there have been no attempts to surgically render Australian elapid snakes harmless, or to do so via excision via the roof of the mouth.

The case involving Millar had mixed and unfavorable results, for reasons given by Millar in his paper and ended up in the premature deaths of both snakes, one at least as a result of complications through sedation at time of surgery.

The cases documented here were not only successful, but left no readily detectable evidence of surgery within a short time. Effective recovery was within days as evidenced by rapid healing of wounds and routine voluntary feeding by snakes.

The procedure is simple and effective and has been documented here to separate fact from fantasy in terms of the procedures possible to render dangerously venomous snakes harmless (or 'venomoid') and to enable others contemplating such surgery on snakes a safe and effective means to do so.

The procedure given here should be used as a model for others intending performing such surgery on dangerously venomous snakes.

INTRODUCTION (WHY BOTHER?)

In my own case, I have been keeping and handling deadly Australian snakes for some decades and never had a call to remove the venom glands from snakes.

The push to remove venom glands came from several angles and arose due to my seeking a permit to publicly display, show and handle deadly species of snake and minimize the inherent risks, both real and perceived.

Noting the increase in public liability insurance problems and related occupational health and safety laws, particularly in the wake of insurance disasters in Australia such as the Longford Gas Explosion, HIH Insurance Company bust up and so on the idea of using deadly snakes for displays in close quarters became problematic.

In the period 2002-2004 I received inquiries from numerous people who wanted a live and interactive display of deadly snakes, but without the associated risks. Included here were the managers of the Heritage Golf Club at Chirnside Park (Victoria), Diamond Creek Public School at Diamond Creek, the Bayside Christian College at Baxter and others.

In other words these people wanted to have their cake and eat it too.

Whilst in the past it was easy to tell these people to simply accept the possibility of a snakebite risk, recent events here in Australia were changing things.

In the 1990's a respected (but then young) keeper Aaron Briggs from Coburg, (Melbourne, Australia) was bitten by a pet Death Adder (*Acanthophis antarcticus*). That in itself wasn't too exceptional, but for the fact that it was a quiet news day and the local news media got onto the story.

Within days the "do gooders" were demanding that reptile keeping be outlawed and the herpetological community had to fight a rearguard action to preserve our hard won rights.

Ultimately, the keeping of venomous snakes was made more restrictive (including outlawed to under 18's), but no other rights were lost.

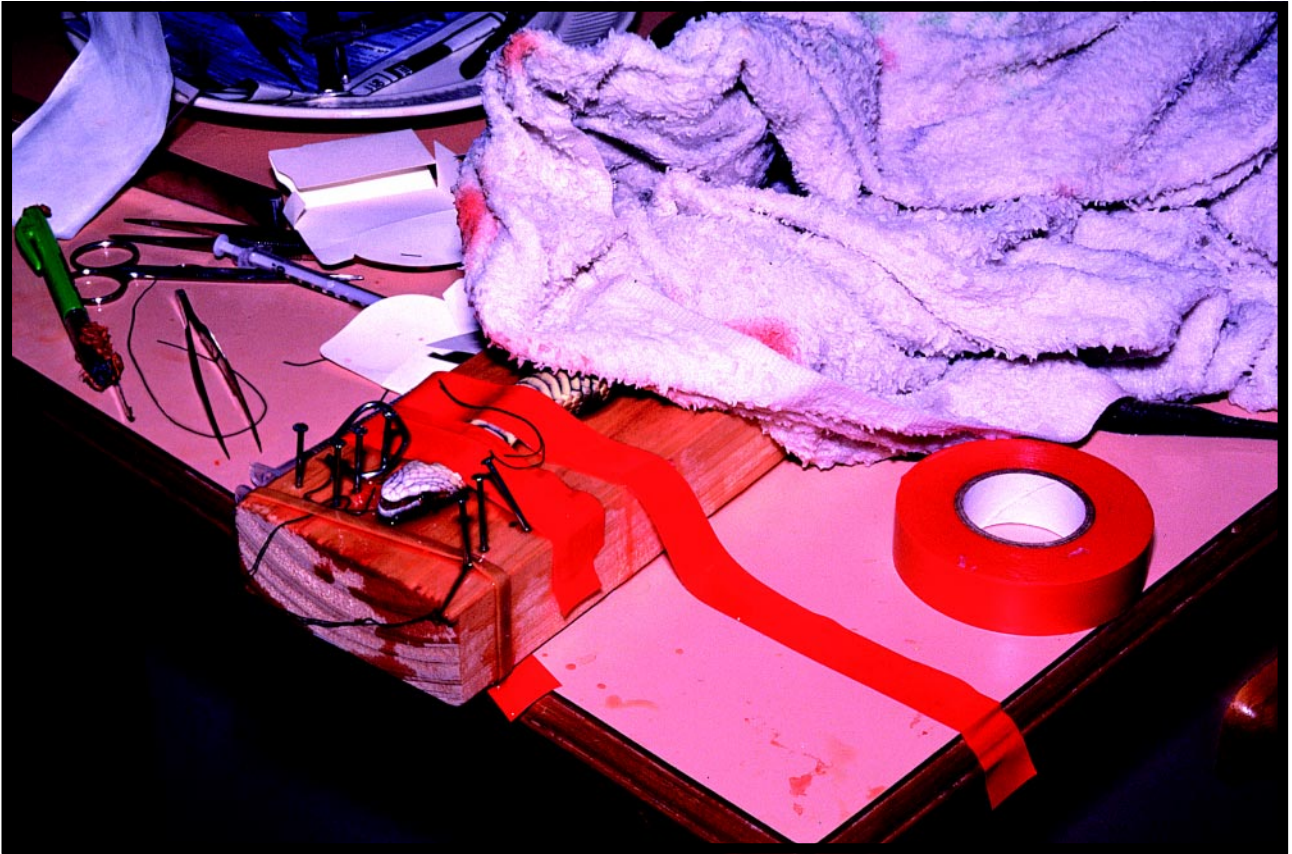
Just prior to doing a snake show in 2001, Fred Rossignolli was bitten by a large King Brown Snake (*Cannia australis*). Instead of doing a snake show, he landed at the Maroondah District Hospital and again there were calls to outlaw the keeping and displaying of venomous snakes.

Those calls blew over and nothing significant changed, but it was a wake-up call to those who keep or handle deadly snakes.

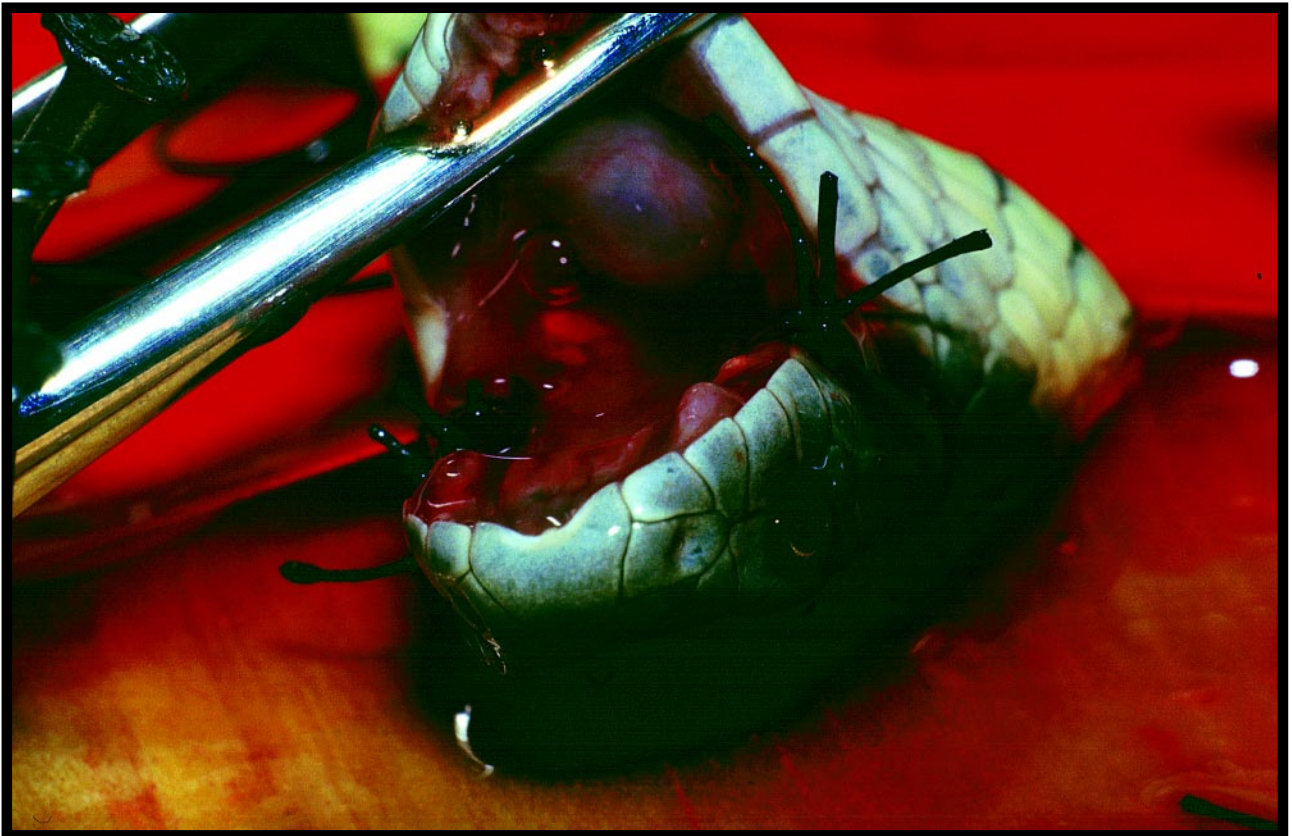
Regulation of exhibitors did however tighten up to include the need for more secure (lockable) cages/containers, warning labels and the like.

In the 2002 Melbourne Agricultural Show, Workcover officials whinged at Fred Rossignolli for walking barefoot in his pit full of dangerously venomous snakes.

Fred wasn't allowed to show snakes at the 2003 show, even though his show was generally regarded as "the



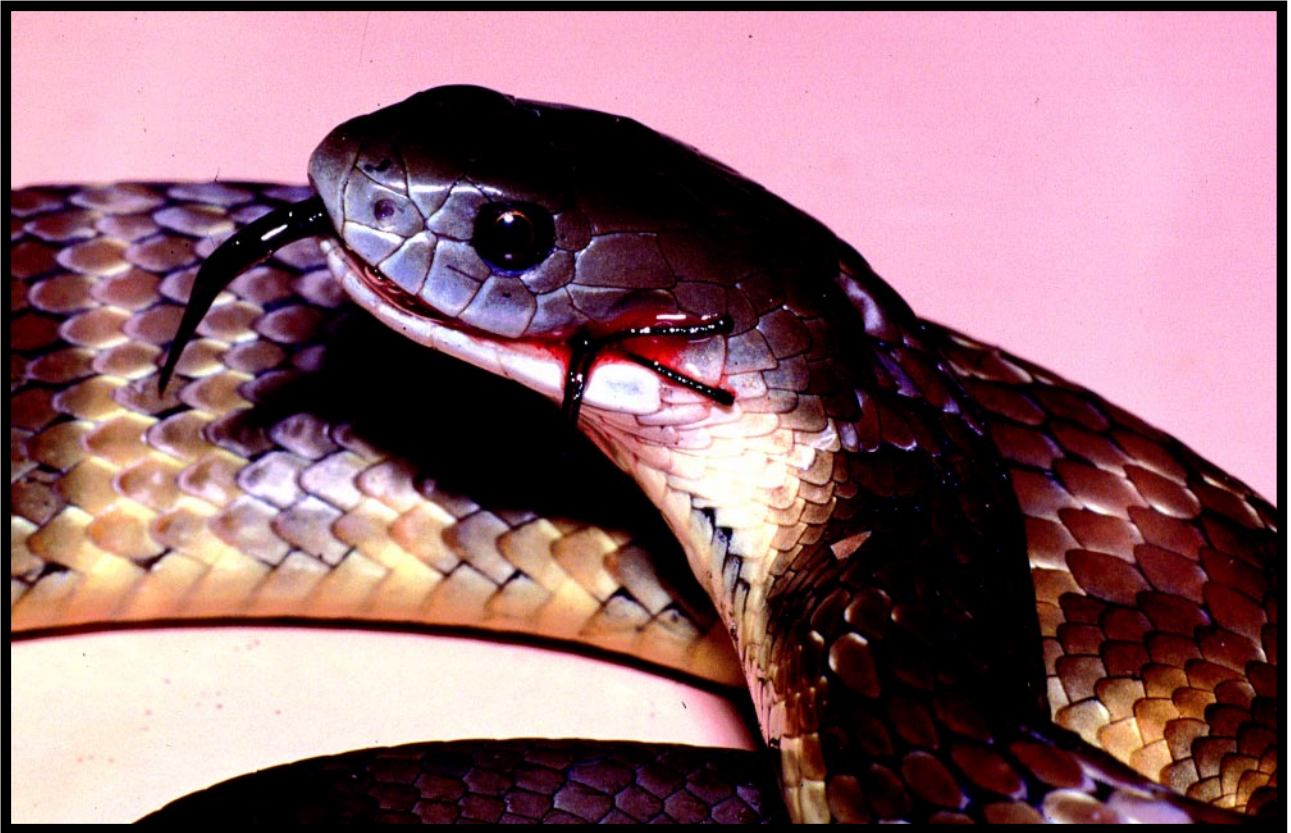
Above: The first live Tiger Snake operated on at the completion of surgery and just before being released from the operating plank. The only restraint for this snake was the tape shown and the iced towel. In later operations, more of the body was restrained by tape and twist ties were used instead of rubber bands to hold down the lower jaw. Nails were added to the side of the plank adjacent to where the others are affixed. This snake was totally sedated in this position. Below: The sutured up mouth of the first live Tiger Snake (*Notechis scutatus*) operated on. This photo taken immediately after surgery and just before snake was fully released from the operating plank.





Above, below and top of next page are photos of the first operated on Tiger Snake minutes after the previous photos were taken and now fully revived. The next day it wanted to feed. The operation was 100% successful. Sutures were removed about a week later and the mouth wounds healed totally shortly thereafter.





X VNS1 - Operation on a large 103 cm long Female Tiger Snake (*Notechis scutatus*). On the right side the venom gland has been removed. To the left the gland has been separated and raised from its position and the join to the skull severed at the rear end. The photo shows how in this species (and most Australian elapids) the venom gland is well defined very close to the fang (into which it narrows and runs into via the duct). It is necessary to cut as close to the fang as possible. This snake voluntarily ate a mouse within days of this operation and while the sutures were still within its mouth.



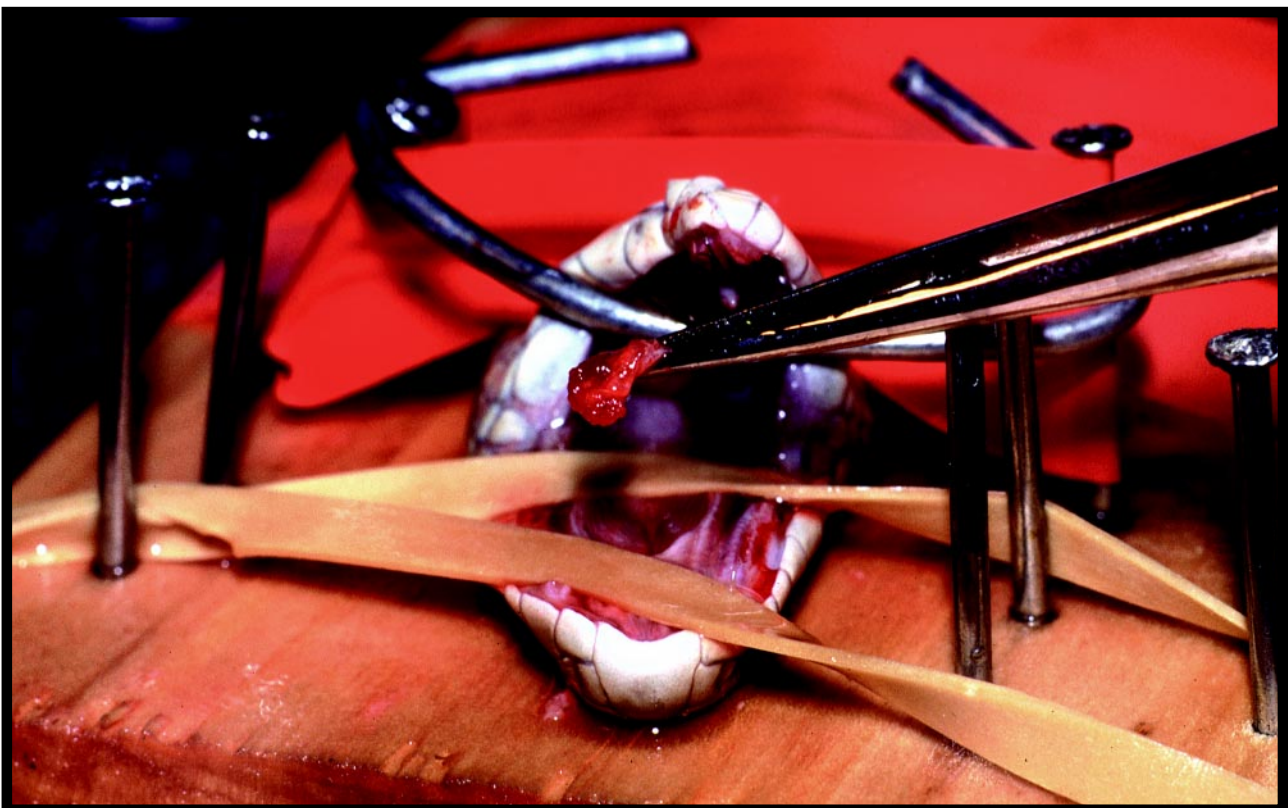


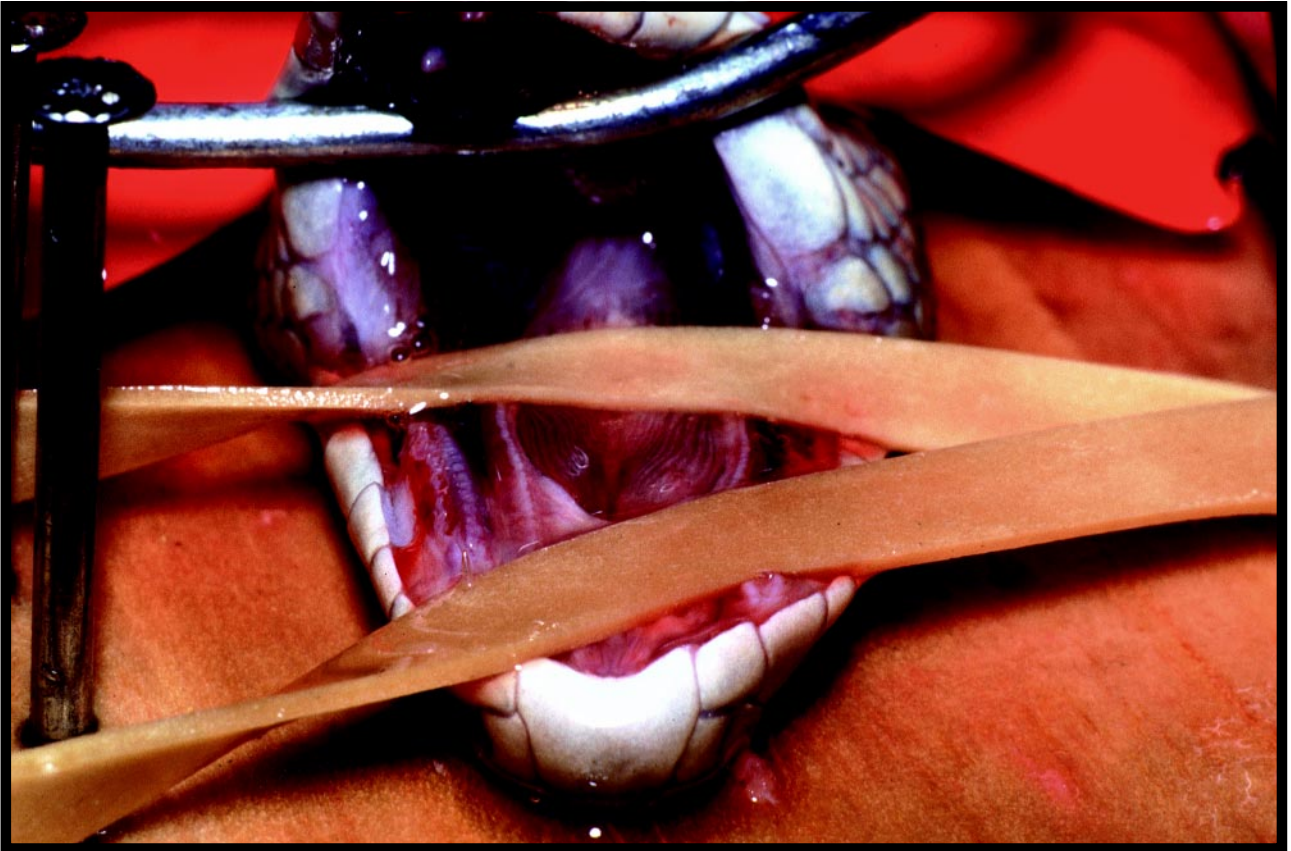
Above: A large male 117.5 cm male Eastern Brown Snake (*Pseudonaja textilis*) on the operating table. Note means by which jaws are affixed open. In this case it is rubber bands for the lower jaw and a fixed curved wire for the upper jaw which is designed to remain in position between the nail heads the snake's jaw and not move.

Note how the nails are used as points to fix or direct the tape and metal that hold the mouth open and in position.

Note how the upper body of the snake is restrained with electrical tape. Also note the two iced (soaked in water then frozen) towels, white on top and blue on left side, which form a blanket to keep the snake sedated. The snake can be held immobilized in this position for as long as the operation takes and then automatically revives once the towels are removed and as the snake warms up.

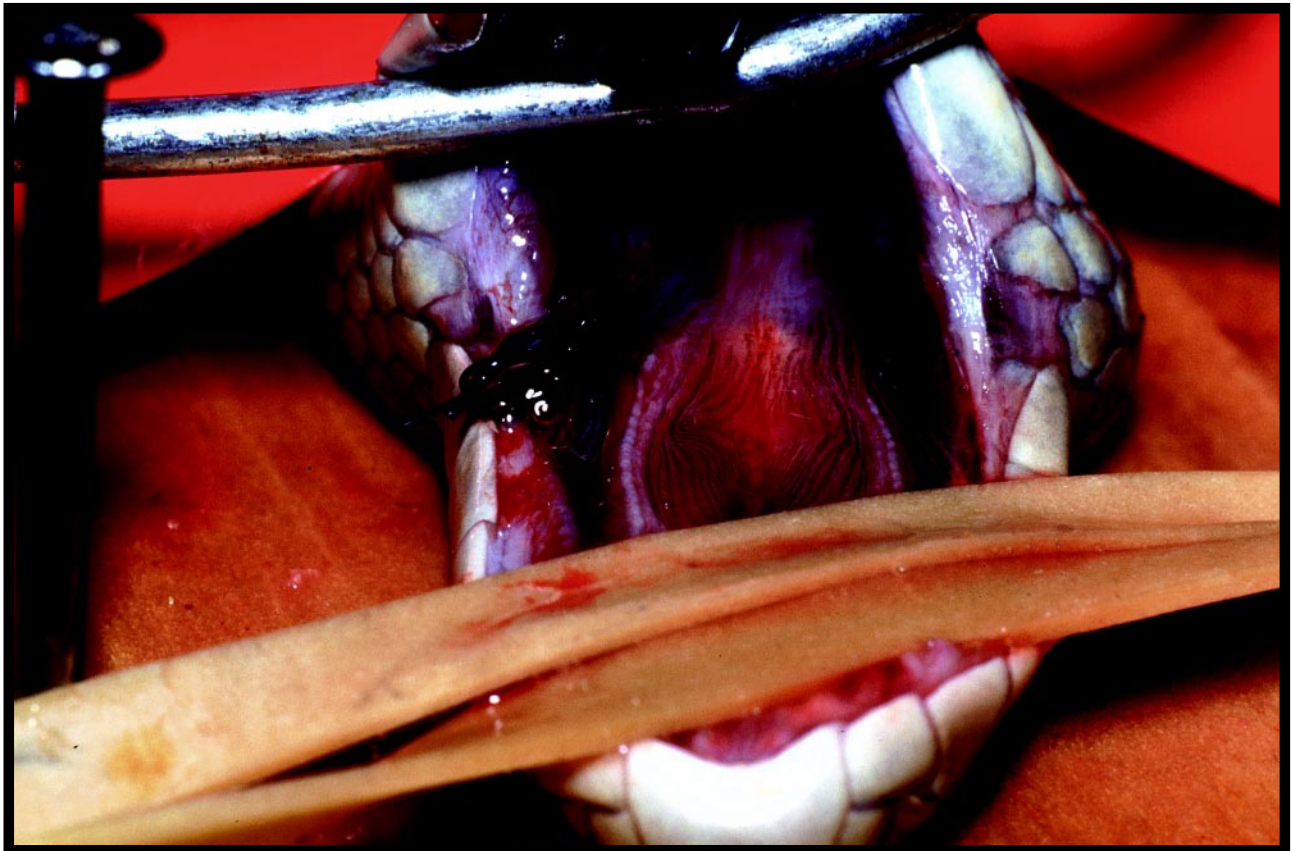
Below: A closer view of the operation, this time with a venom gland removed (both now removed) and held in the forceps. Note how little bleeding occurs around the operation area (as evidenced by the general lack of blood at the site of the lesions) due to the lack of major arteries and the cool temperature of the snake.





Above: The same Brown Snake with both venom glands removed and the holes unsutured.

Below: The same snake with one side sutured up.





Above: The same Brown Snake with both sides sutured up. This snake voluntarily ate a mouse within days of this operation and while the sutures were still within it's mouth.

best" and no incidents occurred the previous year (bearing in mind Fred does such shows daily and has only been bitten once in ten years doing such shows).

Yes, he's had a few "food bites" at home, but that's another story.

Another snake handler, Simon Watharow, "stole" the Melbourne show gig from Rossignolli on the basis that his display was "safer", even though it was generally conceded that the entertainment value and educational benefit of the Watharow show was vastly inferior to Rossignolli's.

(Rossignolli free handles his snake, while Watharow uses pinning sticks and hooks only).

In other words, there was a push from persons and organisations outside of myself for a safe alternative to educating the public with deadly snakes, with all the benefits of the handler being able to free handle snakes as needed, but at the same time to minimize the risks.

Internet forums are rife with comments about venomoid snakes (generally negative) and I am not going to add my own views to the already polarised views online already, save to dispel a few myths under the next heading and elsewhere in this paper.

However, having been involved in snake science for more than 3 decades, I can assure readers that my own handling skills are sufficient to exclude the need for me to neuter the venom glands of snakes for my own ends.

MYTHS AND CORRECTIONS

Venomoid is the term used for snakes who have had their venom glands removed and the name given to surgical procedures to do this.

From a practical point of view, snake venom is of no discernable benefit in terms of digesting food.

This is evidenced by the fact that pre-killed food is digested just as easily (and rapidly) as food killed by snake venom.

In other words any breakdown of tissues of prey by venom is of insignificant benefit in terms of aiding digestion, or being essential to it.

Claims to the contrary have no substantive basis.

If contrary claims did have a factual basis, then it would not be possible to feed venomous snakes indefinitely on pre-killed food, or in the case of some Australian elapids, such as Tiger Snakes (*Notechis scutatus*) a diet of items as diverse as dead fish, steak, sausages, steak, pork, ham and Calamari (squid), all of which I have done.

Similar applies for other elapids, fed nearly as varied diets, including Red-bellied Black Snakes (*Pseudechis*

porphyriacus), eastern Brown Snakes (*Pseudonaja textilis*), Small-eyed Snake (*Rhinoplocephalus nigrescens*), Death Adders (*Acanthophis* spp.) and others.

Removal of venom glands in other words is merely the neutering of the snake's ability to kill live prey. As the process is not reversible this means that the snake can (probably) not be fed live food again.

In the captive situation of keepers like myself, this is of no relevance as food given to all snakes is dead and taken from a freezer. It does however mean that the snake cannot be released into the wild and expected to fend for itself.

But the inability to immobilize live prey is the only measurable negative of venomoid surgery and in the real world of herp keepers is rarely an issue.

Performed correctly, venomoid surgery is not particularly painful for the snake and recovery from the surgery is very rapid. This is amply demonstrated later in this paper.

As only non-essential soft tissue is excised, recovery speed is fast due to the fact that no bone or tooth repair is necessary and healing tissue is generally fixed (not moving) and not in use as would be the case for something like a limb in a human.

Snakes on which surgery is performed (properly) will often be willing and able to take food almost immediately after operation, as in taking food offered within days.

Complications from surgery in the form of injury, infection or arising from anesthesia in properly performed operations are almost unknown (and totally unknown in my own situation) and in the rare cases where they may arise, are (presumably) easily treated and dealt with.

Venomoid surgery is not essential to snakes in that it is not necessary to save the snake's life.

It is best classed as "elective surgery" and hence should only be undertaken on healthy well-adjusted snakes in circumstances where there is no known risk to the snake from such a procedure.

It should be treated in much the same light as (sexually) neutering a dog or cat, although the latter operations have far greater long-term effects on the health and personality of the subject animals.

WHO SHOULD PERFORM VENOMOID SURGERY ON SNAKES

As a procedure it is remarkably simple and while it would be generally advised that a qualified veterinary surgeon perform the operation, this is not necessarily essential or for that matter the most important requirement. What is more important (and far more so) is that the operation is only performed by a person experienced in performing such operations and who is familiar with the exact procedure to be followed in terms of what must be done.

This experience can only be gained by doing such operations and should therefore be gained in the first instance by studying of appropriate dead snakes upon which the operation can be practiced as often as is necessary.

Anesthesia procedures used to neutralise the snake during the operation should be fully tested on appropriate snakes prior to doing a "real" operation, so that nothing is left to chance when the first operation on a live snake is performed.

The operation should only be performed by a person familiar with the snake species to be operated on and who is skilled at handling the reptiles.

Noting the pre-operational matters of sedation and after the operation itself, revival, it is essential that the operation be performed by a person who is skilled and experienced at handling the said species.

This paper explains a successful process used and refined, so that if and when others need to perform such surgery, that it can be done using proven and tested methods that will not adversely affect the snake/s in question.

VENOMOID SURGERY

The species in question here to be 'neutered' so to speak, were Tiger (*Notechis scutatus*), Eastern Brown (*Pseudonaja textilis*) and Copperhead (*Austrelaps superbus*). All are deadly venomous snakes and the first two account for the vast majority of fatal bites in Australia, including among keepers and non-keepers.

The only record of venomoid surgery in Australia was the case published by Dave Millar in *Herpetofauna* in 1976.

In that case involving two Tiger Snakes, he made an incision into the side of the head (from outside the head) and removed the gland immediately underneath.

Millar used various methods to immobilize the snakes during the procedure and for reasons unknown did two operations on each of two Tiger Snakes, removing one gland at a time.

For the first operations, the snakes were immobilized by cooling to a state of torpor and then by being held down at the relevant temperature were operated on.

The snakes apparently healed well and both accepted food a week later.

In the second operations, to remove the second venom glands the snakes were immobilized with chloroform. This time the operations were not a success. One animal developed a series of (linked?) infections and died, while the other had a somewhat checkered road to recovery.

It was presumed that the problems arose from the sedation process and not the surgery itself, but this isn't

certain.

Either way, it is clear that the Millar operations were an abject failure.

While there are frequent claims made about venomoid surgery by reptile keepers, there has been no proper paper detailing a tried, tested and apparently risk-free procedure for doing the operation and so before commencing the first operation further research was required.

Consultation with veterinary surgeons and the relevant texts (such as Fry 1991 and Mader 1996), revealed no shortage of ways to anesthetize snakes and immobilize them.

However a common complaint by various veterinary surgeons was the differential between snakes in terms of required dosage needed to immobilize the snakes, even of the same size and species.

Related to this was the fact that the margin for error in such procedures was not always great and while with experience, losses of snakes under anesthesia are not great, there always remained a risk.

To the contrary, cooling a snake above its known thermal minimum didn't seem to present any problems (see below for an exceptional case) and based on the Millar case (above), it seemed to be the preferred means of immobilizing snakes for the operation.

Several veterinary surgeons recommended the use of a modeling clay mould with "arms" to hold down and immobilize sedated reptiles when surgery was to be performed.

In the first instance, a variant of this was planned to perform this operation, but it was ruled inferior to the final means (explained below), as even with clay to restrain a snake, it was possible for a partly sedated snake to be able to squirm its way out of the holder.

Bearing this in mind, in preparing for the surgery in my case/s, a far more effective means was devised to restrain snakes without incident. This is explained later and shown in the photographs taken at the time and in the absence of other yet unknown better procedures, I strongly recommend that persons doing venomoid surgery use the techniques developed by myself as given in this paper.

The method I devised allowed me to immobilize any species of snake without causing them harm, keep them immobilized as long as necessary and then to allow them to revive almost immediately after surgery.

My means of sedation of snakes was via cooling to a temperature sufficient to immobilize the snake, but not to be life threatening.

Tests on (Melbourne) Tiger Snakes, established that they could be cooled to 5 degrees Celsius without incident. At this temperature they were effectively immobile and could be manipulated almost as one pleased.

Fry 1991 (p. 421) mentioned that to maintain this temperature on reptiles during surgery (4 degrees in his case), ice-baths could be used.

Claims that cooled snakes were abnormally prone to ailments if cooled in this manner (see Fry 1991), did not correlate with my own experience in terms of cooling reptiles in fridges for photographing.

Put simply, the said reptiles recovered perfectly and with no ill effects, long or short term!

My own view is that authors citing cooling as cause of disease have confused short term cooling with long term keeping at sub-optimal temperatures, which is an issue unrelated to surgery or this paper.

Once a means had been developed to sedate snakes, the only remaining hurdle was the means by which to conduct the surgery.

But before I explain this, I will outline some essential facts about the snake's venom glands.

The venom glands are located above the jawline and generally posterior to the eye to about the back of the skull, usually in the vicinity of and level with the end of the mouth line, or slightly past this and slightly above. This seems to be the positioning in all venomous snakes, including for example the Pacific Rattlesnake (*Crotalus viridis oreganus*) as shown in Fry 1991 (page 450, top three photos).

The glands (one on each side of the head) are sited under the rear head shields and surrounded by muscle tissue. They sit outside the jawline and with the surrounding muscle tissue form a major part of the flesh in the posterior dorsal head region around the back of the skull.

The exact size and positioning of the venom glands varies from snake to snake, but appears to be larger (and reaching further back) in larger snakes of a given species.

To the rear, the gland has a rounded end, while anteriorly it narrows to form a vessel or duct that runs under the jaw and into the fang. The length of the venom duct in terms of its run from the venom gland to the fang tooth also varies from snake to snake.

It is not always distinct, in that the narrowing may be fairly rapid, or in some snakes more gradual and this variation appears to even occur within a given species and even with age or size.

In some snakes the duct is up to 1 cm in length and very obvious as a duct, while in some snakes it appears to be almost indistinct with the venom gland almost appearing to narrow and run into the fang.

While more-or-less pointed at one end and with a blunt end at the posterior end, the glands are more-or less rectangular and encased with muscle tissue which appear to help push the venom to the fang.

This muscle tissue is fairly easy to separate from the venom glands along the length of the glands, but at the rear, both gland and muscle is affixed to the rear of the head or the flesh of the neck. To separate this, one must cut it.

At the anterior end of the gland, the venom duct must also be cut to remove the gland, and when doing so, it is important to cut the duct and not the anterior part of the gland (otherwise leaving part in the snake).

While a number of texts detail the structure of venom glands in snakes, preceding surgery it was essential for me to dissect snakes and look at these structures for myself.

Initially it was envisaged that I'd dissect dead captive snakes as "test runs" for surgery", but in late 2003, I was fortunate to find several road-killed Tiger Snakes in order to inspect them.

While some corpses were quite decayed and smelly, they were still adequate for me to inspect the venom glands and test means of conducting surgery, instruments to be used and even refine the means by which I eventually immobilized the snakes in surgery.

Tested were both the "external excision" method, by going through the side of the head, and the "internal excision" method, of going through the roof of the mouth, which was ultimately decided to be the preferred method.

It was only after all aspects of surgery had been addressed and tested as best as possible on dead snakes that an operation was conducted on a live snake, which had already been immobilized and kept so for a period equal to or longer than an operation would take and recovered without incident.

Before detailing the first venomoid operation, I should mention that I subsequently developed an effectively foolproof method of putting reptiles (of any species) into a state of cold torpor without causing risk to them and this will be detailed later.

THE FIRST VENOMOID OPERATION

The method used for this operation was the same as that used for all others, save for the manner of cooling and minor refinements to the means of restraining the reptiles.

The venom glands were removed by an operation into the roof of the mouth to remove them internally, the result being no cutting to the external surfaces or scales of the head.

The subject was a half-grown Tiger Snake. It was put in the fridge to get its temperature to the desired 5 degrees Celsius, which was the setting in the fridge.

The snake was in a state of torpor, but obviously still alive.

It was then quickly removed from the fridge and placed upside down on a 60 cm long wooden plank (removed from the fridge) and then by its head and snout sticky taped down to the wood, with the snout and neck at a predetermined spot and held down.

The tape ran over the head only.

The following section of the neck was quickly sticky-taped down to the wood (with the tape running around the board in full circles), with the rest of the snake then being unrestrained but placed over an adjacent towel.

The area near the heart (about 1/8 of the way down a snake's total length) was not restrained in any way (nor was lower down the snake's body in this operation, but for later operations lower down was restrained as well, as sometimes this moved away from or out of contact of the towels and the further restraint prevented this).

The towel (just mentioned) had previously been folded, wet with water and frozen solid. Before the operation it had been allowed to thaw to the extent that it was still mainly frozen but the surface was wet and it could also be bent or moved with some difficulty.

In other words it was pliable.

(At a room temp. of about 20°C it takes about an hour for a towel to reach this state and it remains OK for about an hour and by rotating towels, a supply can be maintained indefinitely).

A second similar towel was placed over the snake's body, forming a cold blanket above and below the snake. This design allowed me to maintain the cold torpor during the course of the operation, but not actually freezing the snake.

The tape over the snake's head and snout was then removed (having been in place for only a few seconds), with the snake itself opening its mouth to breath.

(For those unaware, the glottis, or windpipe of a snake is not always open. It opens and shuts periodically and a momentary blockage is not a fatal condition, so long as it is kept just that, momentary).

The lower jaw and upper jaw were then fixed in a position to allow surgery to start.

Veterinary surgeons suggested using string, sutures and other materials to affix the snake's jaws during surgery, but after some previous testing on the snake (without actually doing surgery), it'd been established that the best means to affix the jaws and head in place was as follows.

The neck region had already been fixed flat and in a straight line with sticky tape.

By its nature, this effectively prevented the snake from any means to squirm loose, even if it were to regain consciousness or an ability to move during the operation, which may occur if the snake were insufficiently cooled.

No other effective way was found to properly restrain the snake.

To either side of the head and neck region of the snake and already affixed to the wood plank, were nails. These had been affixed as contact points for so-called "twist ties".

These are thin metal strips that can be easily bent and twisted to form a tight line or knot.

A long strip was used to affix the lower jaw to the wood, while a second strip was used to do the same to the upper jaw, making sure that the glottis (windpipe) remained clear.

In a breathing snake, this periodically opens and shuts and this remains the case in the snake as it is operated on.

A hard-wire frame was set between two nails to hold up the lower jaw (on top) to keep the mouth open for the operation. The nails were set (slightly in facing) to make the frame naturally rise and fix in position, thereby holding the upper jaw in place and fixed.

Nails on the board (several on each side) were spaced apart to allow for any snake to the size of a three metre elapid and to allow fixing of more than one wire to hold the lower jaw down, so that the fixing wire could be moved if needed if cutting was needed where the wire crossed the snake's mouth.

Due to the lifting of the mouth, the twist ties ran through the nails on either side and (after the first operation) on to other nails placed on the sides of the plank (as opposed to the top side where the snake lay).

This means that the wire twist ties could be also affixed to these lower nails and hence pull down the mouth (upper jaw on bottom) to be fixed to the board.

Once affixed securely and so that there was no possible movement of the snake, surgery began.

The mainly unrestrained lower body of the snake was coiled under the iced towels and allowed to move somewhat.

In a state of cold torpor and during the operation, some limited movement occurs and is desirable as this shows that the snake is still alive and in good health.

For the record, most movement seems to be in the caudal region in the form of undefined coiling and movement.

In terms of the head, the only possible movement is the windpipe opening and closing and the flickering of the tongue, which also gives a good indicator of the level of consciousness of the snake.

If one looks, one sees the glottis opening and closing throughout the operation.

If movement declines (due to cold) the towels are moved apart somewhat to allow warmer airflow within and vice-versa if the snake appears to be warming up.

That the head is clear of the icy towels and hence warmer than the rest of the body, is not an issue (see later) and never caused problems.

Using standard surgical instruments (scalpel, tweezers, etc) sterilized in (continually) boiling water, for at least ten minutes (before the commencement of the surgery and allowed to cool to room temperature), the venom glands are separated from adjacent tissues and then cut loose from the ends where they are affixed to the venom duct (anteriorly) and the rear of the head.

It goes without saying that the anterior cut includes as much of the venom duct as possible.

The limiting factor is where the duct enters the jawline and the fang structure. That part of the duct cannot be cut.

The procedure followed was to remove both venom glands first.

The result was the same for each side of the head.

This was a (relatively) large gaping hole between the side of the head and the rear of the upper jaw, heading from about the region of the eye to the rear of the head (and in larger snakes operated on later, the cavity ran almost to the upper neck).

This hole was then sutured up with (fairly standard) Polyamide monofilament non-dissolving sutures. (In the first snake I used assunyl USP/30 - EP2 75 cm TS-24.3mm).

This snake had three sutures on each side and the result was that the (elongate) hole was effectively closed.

The whole lower mouth area was then irrigated liberally with Povidine Iodine (Betadine) and Neosporin (Antibiotic).

Because I had complete control over the snake's state of consciousness, I was also able to accurately measure the snake and photograph it in its operational state before terminating the procedure.

At this point the top iced towel was removed to allow the snake to warm at room temperature, (which commences more-or-less immediately - within seconds).

Also as soon as the towel was removed I commenced removing the tape holding down the snake.

This is merely cut next to the snake and then carefully peeled from the snake's scales.

No damage is caused to the snake's scales.

The final section of tape (about 3-5 cm) is not cut until after the head is unsecured.

The twist ties are merely released and then the head is held down while the final piece of tape is cut and carefully separated from the snake.

It was then placed back into its (immediately adjacent) cage.

The cage was typical of what I keep most elapids in.

This is a clear plastic tub with nothing more than a newspaper substrate, sealed upturned pot as a hide and a water bowl, with a heat mat at one end of the cage (underneath it and radiating up).

The 'sterile' nature of the cage is important so as to prevent dust and other material finding its way into the wounded area.

Within minutes the snake had recovered and save for bits of betadine and perhaps coagulated blood giving the head a bloodied appearance, as well as the ends of some sutures hanging down the sides of the scales, there was no evidence of the operation.

The snake moved about normally and flicked out it's tongue properly.

The snake appeared to recover without incident and daily inspections showed a linear recovery.

No further treatments with anything was done.

The sutures were removed 9 days later (later snakes were left with their sutures longer, usually about 14 days). At this point there were a few uninfected scabs visible on parts of the affected regions, but the snake appeared healthy.

Three days later the snake had no signs of wounds at all and was fed two mouse tails.

The very small feed was deliberate so as not to adversely affect the healing wounds.

In terms of the snake's behavior, it was completely normal and there was no outward sign that the snake was venomoid.

FURTHER NOTES ON THE FIRST VENOMOID OPERATION AND LATER ONES

During the operation, bleeding of the cut areas led to the tissues being obscured in blood, momentarily stopping the progress of the surgery.

To remove the blood a 5 ml syringe with chilled (near freezing) water was used to squirt out the blood. The blood tended to coagulate almost instantly and the operation was not impeded.

It was suggested that a soldering iron be used to cauterize wounds and stop bleeding, but due to the effectiveness of the syringe method, I never bothered testing the alternative.

It was also deemed that the syringe method had less risks associated with it.

Blood loss is not an issue in terms of this operation as no major arteries run near the operation area and hence in terms of the mass of the snake, blood loss is minor.

Based on later operations, it became clear that bleeding is a more serious problem in warmer snakes, the difference being noticeable in snakes even a few degrees warmer, but in cooled snakes bleeding is never a serious impediment to the surgery.

However this fact is another factor that favors cold torpor as a sedation method of choice as opposed to other means available.

Due to the small size of the first snake and the lack of tissue left between the side of the head and the hole, sutures were placed through the labial scales.

After their removal, the labials healed perfectly and there was no external evidence of the operation. In larger snakes, it wasn't always necessary to suture through the labial scales (depending on how I cut to get the venom glands out).

In the first operation I used a head magnifying glass to be able to better see the area operated on.

In larger snakes (such as 1.5 metre ones), this wasn't needed. The naked eye was sufficient to see what was necessary.

Some snakes operated on later did not have any antibiotic applied to the wounds. They merely had betadine applied. This was an inadvertent error at the time, but the snakes still healed rapidly and without incident.

THE FINAL RESULT

While there are many claims by critics of venomoid surgery about disfigurement of snakes by venomoid surgery, the reality (in these cases) is actually quite different.

Based on the size and placement of the venom glands, it stands to reason that the result is a slight narrowing of the head in the relevant region.

However due to the variation in head size within species, this tends not to be noticeable, at least in terms of the Australian elapids operated on.

This lack of noticeability is further exemplified by the fact that the snake's skull is fairly flexible (unlike humans) and due to the original bone structure, scale placement and so on, as not removed in the operation, the head and skull tend to sit in a manner essentially the same as before the operation.

The difference is almost undetectable.

To a person who has actually done the surgery on a known snake and who has similar unoperated on snakes of the same species in their collection (as I did), it is possible to notice a lack of rigidity and hardness of the posterior of the head when handling snakes by the head and neck.

That is perhaps the most noticeable trait of venomoid elapids and still one that few persons would ever notice.

To put the final result in perspective, after the success of the first operation, several other snakes were operated on via the same or similar procedure.

While still carrying sutures, several experienced (and well-known) reptile keepers came and looked at my snakes and not one noticed any difference in the snakes or even their sutures.

As for the snakes with sutures removed, well, these same keepers (and others) never had any idea that they were looking at venomoid snakes.

To them the snakes appeared normal in every way!

SUTURE TYPES

After the first operation's success, several more were planned, this time on several species, although it was mainly Tiger Snakes that were first in line to be operated on.

The first seven operations all went perfectly, with four done in immediate succession on one day.

Different sized sutures were trialled and I had a preference for the original (large) size as opposed to the smaller ones, which I found harder to use and hence extended the time taken to perform the surgery.

It was also suggested that dissolvable ones be used, but based on the ease of removing the non-dissolving ones, this wasn't an issue and so they weren't tested on the first snakes (but have been used since and with equal final success).

As with all other aspects of the procedure, suture types should be trialled well before the first operation if there is doubt as to whether or not you will be able to work with one or other type of suture or needle.

In line with most surgeons, I preferred curved needles to straight ones.

SPEED OF SUCCESS

While I may perhaps be criticized for my next comment, I will make it nonetheless.

Notwithstanding the precautions taken for the first operation, there was always deemed to be an element of risk and hence the snake operated on was that deemed most 'expendable', although in my collection, no snakes really fitted the category of 'expendable'.

I also exercised perhaps the greatest degree of precaution in terms of what I did and didn't do before, during and after the operation on the first snake rather than the later ones, due in part to my familiarity with what the snakes would do and how they'd respond.

One of these things I was cautious about was in terms of offering food.

While I wouldn't necessarily recommend it to others, I have offered food to snakes (of several species) just three days after being operated on and they have eagerly grabbed food and eaten it.

This is mentioned here merely to show how rapid recovery is, so as to point out that the surgery is very minor in terms of potential things that may occur in the mouth of a snake.

By way of comparison, mouth-rot (canker) infections in snakes typically manifest in hard bone tissue and even a mild case of this disease would cause a snake far more pain and discomfort than a venom gland removal operation as performed in the manner outlined here.

An example of the discomfort caused by mouthrot was seen in a Death Adder (*Acanthophis antarcticus*) in my collection that had a serious case in 2003.

That mouthrot case (associated with a reovirus infection) came twice (as in the mouthrot appeared, seemed to heal and then relapsed) and the final result was loss of a bone in the lower jaw.

It literally rotted and fell away.

Eventually the infection healed and the snake recovered, but minus the lower jaw bone (on one side).

That the snake was able to carry on as normal with this impediment is testimony to what a snake can live without.

Yes, the snake is alive and well at then time of writing this paper.

More importantly is that during the weeks of infection, this snake refused to eat.

Based on the speed of recovery from the venomoid operation by venomoid snakes, and when they will eat, it can only be assumed that the operation (if performed correctly) is neither particularly painful or particularly damaging for snakes.

Now recall, that snakes don't get morphine and other painkillers after operations.

It would also be safe to infer that a snake in pain won't eat and if snakes are eating within days of being operated on (in the mouth no less) then clearly the pain cannot be that great.

Hence allegations of cruelty to snakes in terms of venomoid surgery performed correctly do not have a basis of evidence.

A CASE OF OVERCOOLING AND IT'S SIGNIFICANCE

As mentioned before, later operations were done and some snakes were done in succession.

To cut corners, snakes were cooled in a freezer and removed at the point that they appeared to be in torpor.

This was when the tongue would still flick, but that the snake could barely move.

One subadult male Tiger Snake was cooled and appeared to be still fairly active and so was left in the freezer for a few more minutes.

Upon being taken out the second time it appeared to be dead.

The mouth could be opened and the snake would make no attempt to move or close it.

The snake also appeared to be limp, as befitted a dead snake, not rigid as a live torpid snake is.

I was uncertain as to whether or not the snake was dead and as befitted the situation, a state of anxiety ensued.

The snake was allowed to warm up at room temperature (then about 20 degrees Celsius), but did not appear to come to life.

However it was noticed that the heart was beating normally.

Over the following three hours, the snake slowly appeared to revive.

At first it was the snake's tail that moved slightly when rubbed and later the snake was noticed actually breathing (for the first time).

Three hours later, the snake was able to be poked and would move slightly.

The snake was left in its cage overnight and the following morning was still alive, improved, but basically sitting in a listless manner.

Recovery continued and appeared complete within 36 hours.

Based on the fact that the heart appeared normal throughout this period and that it was the snake's voluntary responses that were lacking, it appeared that the head and brain are the most sensitive to excessive cooling. As a result of this 'near miss', the method of cooling was changed.

Snakes were not cooled to quite the same degree as before preceding the operation.

They were only cooled to the point where they could be easily restrained as per the method outlined already.

Once on the operating table the iced towels are used to further lower the snake's temperature to the desired almost totally inactive level.

With the head exposed to the room air of about 20°C (but connected to the rest of the snake's circulatory system), the desired torpor was achieved without adding risk by excessively cooling the head.

As a result of this revised protocol, there were no further mishaps as just described (in spite of many more operations).

Also, the above said snake was operated on a week later without incident and recovered in the same way as the others. (This Tiger Snake is one of the ones in my collection that has eaten food as diverse as Calamari, steak, lamb, beef, pork, bacon, silverside, prawns, fish of various kinds, dog bones, sausage (cooked and raw), kangaroo meat, dog food of various kinds, chicken wings, pieces of cooked and raw chicken meat and other unusual items and is a particularly good exhibit animal as it can be used to dispel the often touted myth that snakes will only eat live food that they have killed themselves).

Just to make things completely clear to readers, if using cold torpor as the means to sedate venomous snakes for surgery, each species should be cooled gradually and closely monitored at the time so as not to excessively cool the snakes.

Use a clear see-through container to hold the snake.

Do not use bags, 'snake-bags', sacks or similar.

Also note that different species do have markedly different cold tolerances.

Australian Lowland Copperheads (*Austrelaps superbus*) from Melbourne needed to be cooled to about 3 degrees Celsius to get the desired torpor, while Death Adders (*Acanthophis bottomi*) from the Northern Territory were torpid at 9 degrees.

To go below the (first) cold torpor temperature for a given snake may be fatal and should not be risked.

Put another way, there is no need to!

An associated point of note is that the risk factors apply most to the head and are highest in a situation where cooling is rapid (as in freezer, rather than fridge).

When cooled, snakes tend to coil up as a natural defence and to retain heat. The head is usually held at the centre of the coils. If however the snake moves when in the fridge to a position where its head is exposed, the head temperature may drop more rapidly than the rest of the body and it's in such a situation that the near miss (of death) as occurred above may occur.

I labor this point as this was the only evident hazard, risk or downside in terms of the procedures outlined. The Tiger Snake I came close to killing was of course the most brilliantly patterned snake of them all.

Furthermore, in an 'elective' surgical procedure, there should not be any risk to the snake subject to the operation and so I highlight this potential risk so that others may not make a similar (potentially fatal) error.

EXTERNAL VERSUS INTERNAL INCISIONS

In the operations I conducted, the incisions were in the muscle tissue lining the mouth between the jawline and the labials. The underlying venom gland/s were then removed.

For those unaware, the venom gland/s are readily detectable as an elongate 'organ' of different structure to the muscle or 'meat' that surrounds it (and is the same as other muscle or 'meat').

The elongate hole was sealed and when healed was hard to notice on the snake.

As one who performed the surgery, I noticed the fact that this part of the mouth was narrower, including as compared with unoperated specimens of the same species.

However I did dummy runs on other reptile keepers and asked them if they noticed any differences (without telling them what it was) and none did.

No doubt this was due in part to the healing process leaving no distinct scars.

In terms of external incisions, if that method were to be used, the cuts should be along the scale lines, rather than across the scales.

This presents some difficulty in terms of the shape of the scales themselves and to avoid a scar it would also be necessary to cut in a flap, separate it from the underlying tissue before going further and then to sew the scale back into the same shape after the venom gland has been removed.

Noting the lack of tissue underneath the excision (after the removal of the venom gland), cratering of the scales would be an almost unavoidable effect.

Another issue of note is that the skin (scales) on the side of the head form a considerably harder thicker and impenetrable skin than any of the other tissue that needs to be cut in the snake's head for the venom gland removal operation.

By virtue of the thickness and rigidity of this tissue, it stands to reason that it'd take longer to properly heal than the soft tissue inside the mouth.

Hence the external excision method of venom gland removal was deemed inferior to the method I used.

There are other disadvantages of the external incision method.

As a snake moves about it will automatically get dust and dirt into any external wound, even if covered with a dressing of sorts.

It has no means by which to clean the wound (on an ongoing basis), save for when it sloughs which is not a regular occurrence.

Furthermore, any keeper will know that sites of cuts and wounds often don't shed properly and in the captive situation a keeper may intervene to get the adjacent skin removed.

The situation for the mouth is radically different.

In fact every aspect of the snake's mouth serves to make internal excision the preferred method of surgery to remove venom glands.

Snakes have no arms or legs and must (in the wild) grab struggling prey by their mouths.

They are hence pre-adapted to deal with the regular mouth wounds and injuries that occur when restraining struggling prey in their mouths.

In other words, the mouth is set-up to deal with the open bleeding wounds that arise.

The mouth's lining is not hard scale tissue, but rather soft tissue.

Hence, once the incisions to remove the venom glands stop bleeding, they present a similar face to the already existing and untouched surrounding tissue.

The mouth is generally kept closed (and safe from dust and debris) and the snake's tongue also assists in keeping dust out of the way.

Gravity also assists, in that due to the fact that excisions are to the roof of the mouth, pus, debris and scab material will naturally fall down and away from the lesions, hence allowing them to remain clean and heal. To the contrary, gravity would work against healing in terms of external and/or semi-dorsal excisions.

Proof that gravity (and the other factors) works in favor of healing of the internal excision wounds also comes in the form of the known statistics for mouthrot infections in snakes.

These predominate in the lower jaw and snout regions, NOT the rear upper mouth.

In that part of a snake's mouth, infections (at least in the early phase of mouthrot) are virtually unknown.

This is for several reasons, but also means that the inherent risk of infection of a snake's mouth following venomoid surgery as outlined in this paper is so remote as to be almost insignificant.

Another point of note is as follows.

In the wild state, snakes grab and hold struggling prey in their mouth. As a result, mouth injury must be particularly common for snakes (and far more so than for mammals such as humans), and as a result it'd be reasonable to infer that they are pre-adapted for rapid healing of such wounds.

This inference certainly holds true in terms of the venomoid surgery detailed here.

Most snakes show no evidence at all of wound or lesion within 20 days of surgery and if sutures are removed earlier rather than later, it is possible for the wounds to have effectively disappeared within 14 days (in most cases).

In the case of the first venomoid operations, the speed of healing was so fast as to be mind-boggling. After several operations, this 'novelty' wore off, but the normalcy of the high rate of healing showed that the operation is in the normal course of events a minor concern to the snakes themselves.

Nothing happened to indicate that the snake's long term health or welfare was in any way at risk, either at the time of operation or after.

SUTURING THE WOUNDS

My aim was to merely close the elongate hole I had made by removing the venom glands.

In most cases two or three stitches on either side were sufficient.

Rarely one or four on each side was required (or done).

In terms of the suture material used, one, or sometimes two packs of "ready to go" suture needle and material was sufficient. However it is always essential to have more than required in case of unforeseen need (even though this never occurred in my cases).

While it may be argued that more stitches are better, I kept numbers to a level sufficient to close the wounds and bearing in mind the fact that I had to remove them about 10-14 days later.

Fortunately, even after cutting out the venom glands, the natural position of the wound I'd made was to be closed. Hence the sutures, didn't so much as hold the wound closed as to stop the sides from rubbing or

moving against one another as would occur if unsutured.

Removal of sutures was easy.

The snake would be simply sedated as for the main operation, the sutures cut and removed with forceps and then the snake placed back in its cage where it would recover.

This was however far quicker than the main operation.

PREPARING FOR VENOMOID SURGERY

As I did, it is important for whoever contemplates this procedure to gain full experience before doing their first "live" operation.

A checklist of materials needed for the operation includes the following:

- Surgical instruments (sterilized)
- Betadine
- Appropriate antibiotic (with known benefits in terms of reptile pathogens)
- Wood plank to affix snake, with several strategically placed nails to anchor twist ties or wire (at all necessary points).
- The nails should be put in far enough to be secure, but bendable so as to allow hard wire to be squeezed on if needed.
- Affixing material - twist ties (for the head and mouth), tape (for the head (initially) and then the upper body)
- Means to sedate the snake such as a fridge (as in fridge/freezer and temporary containers which are clear or with clear lid so that the snake can be observed as it cools).
- Iced (wet) towels frozen and then thawed to the correct level as needed to sedate the snake during the operation.
- Thermometer as required.
- Sterile cage (no loose substrate, water, hide, temperature gradient and nothing else).
- Floodlight on a tripod, or other means to properly illuminate the operating table.
- Head Magnifying glass (at least as a standby).
- Suture materials (must have an oversupply to cover all contingencies).

The twist tie used should be that bought from gardening suppliers that comes in lengths of at least a foot (30 cm) so that pieces can be cut long enough to properly restrain the snake. Smaller "twist ties" as used to secure sandwich bags may not be long enough.

PREOPERATION

The target snake should only be a well-adjusted captive.

Common sense dictates what should be done with the snake both pre and post operation.

It should not be operated on with food in its stomach. However if food has passed through the stomach and is in the intestines or bowel then it is perfectly OK to operate.

All operating materials should be ready well before the snake is sedated.

In terms of planning, a first off operation may take anything up to four hours from start to finish in terms of preparation, sedation, operation and then clean up.

Later operations generally are quicker, but it is fair to assume that three hours is a good time estimate for the whole process.

If doing several snakes at once (recommended when many have to be done), then add an hour for each extra snake.

THE OPERATION ITSELF

In terms of the actual operation itself, it is remarkably quick.

Assuming everything is immediately adjacent (as it should be), the following times are guidelines for experienced practitioners.

- Sedation - up to an hour (quicker if chemical means of sedation used).

If several snakes are to be done at once, then sedation may be via fridge to get snakes to about 6 degrees (cool but not totally torpid) with a freezer to be used judiciously to get the individual snakes to operating temperature, this latter step taking mere minutes, allowing operations to be done "conveyor belt style". Snakes are placed in the fridge, one at a time in line with the speed at which others are being operated on.

(Note: Temperate climate elapids, such as Tiger Snakes, Brown Snakes and Copperheads can sit in a fridge at 6°C for hours without long-term problem, making multiple snake operations easy for these species).

In terms of the operation, the following time lines are reasonable estimates for experienced practitioners.

- Affixing snake to plank, with tape and wire and positioning body in towels to prepare for operation - 2 minutes.
- Removal of both venom glands - 10 minutes
- Suturing wounds - 10 minutes
- Application of betadine and anti-biotics - 1 minute
- Measuring snake (s-v and tail) - 1 minute

- Removal of iced towels, cutting free snake and placement in cage - 1 minute.

In other words 20 minutes is a reasonable estimate of the time taken to conduct the operation. Most operations are completed in under this time.

Some snakes I operated on had other health issues of note that were dealt with at the time of the operation. One large female Tiger Snake had five ticks on it's body. These were left on the snake for some weeks and until the venom gland removal operation, because it was deemed easiest to remove them at the same time. One of the ticks was on the back of the head.

Another snake had skin worms which were cut out at the same time as it's venom gland removal operation.

As a matter of procedure, the moment was seized upon to accurately weigh and measure all snakes.

Weighing was done by placing the snake in a container (pre-operation) and weighing it, while measuring was done at the termination of the surgery and immediately before releasing the snake and placement in the cage.

POST OPERATION

Again common sense is the rule of note.

Post operated on snakes are best left alone to heal.

As a rule, they should be kept in cages on their own and not fed for some time.

I violated these rules on well-adjusted Tiger Snakes and the said snakes still healed without problem.

Feeding is an important issue as it is generally agreed that if a snake feeds and digests it's food post operation, then the operation has been a success.

Snakes of all species operated on would feed voluntarily within days of surgery, including on amazingly large food items.

Included here are Brown, Tiger and Copperhead.

Some sense here is required as if food items too large are fed, then the healing wounds may be damaged.

As to why I rushed to offer food to recently operated on snakes, it was to establish the level of pain and discomfort felt by the snakes from this operation.

It was deemed that if the operation caused undue pain and undue ongoing pain, then the snakes would refuse food.

That they took food so shortly after the operation implied that the pain was neither terribly acute or debilitating.

That so many snakes of so many taxa took food so shortly after the operation, showed that my results weren't just a "one off" from some mad voracious snake, but actually reflected the minor nature of the operation.

Putting it in perspective, most snake keepers know that ailments as "minor" as mouthrot and mite infestations will put snakes off their food, so a snake three days after a (dual) venom gland removal operation is already well ahead of these others.

Healing is so rapid that sutures removed six days after the operation have left the mouth apparently healed and without sign of open wound. In such cases, the only evidence of wound is minor scabs around the suture material itself.

I have preferred to leave the sutures in for ten to 14 days post operation before removal and then not to feed the said snakes for at least three days thereafter.

This non-feeding is to allow the sutured gap further time to heal.

Food sizes should be kept small post operation so as to prevent reopening of the wounds, although this has never occurred in cases involving myself.

I have fed snakes before removal of sutures, the only guideline I have run on being not to cool snakes for suture removal while food remains in the stomach (usually within about 3 days of feeding).

TESTING THE SUCCESS OF THE FINAL PRODUCT

The final 'product' in this case is a non-venomous snake. The means of choice to test is a live rodent or similar. As I don't have ready access to them as a matter of course (I get my rodents frozen), I used live Indian Mynar Birds (*Acridotheres tristis*) (a feral species here in Australia) that are trapped in a specially made bird trap in my back yard. The snake is made to bite into the flesh of the bird and if the bird doesn't die then the snake is presumed harmless.

The test is repeated three times on three different birds to confirm the result.

THE NET RESULT

In terms of the operated on snakes, they have presumably gained as a result of the operation.

Instead of being handled like "deadly" snakes, they have been able to be handled more like harmless pythons.

Those operated on were already tractable and docile and had been selected for operation on that basis.

However based on their deadly nature, their handling had still been constrained despite their tractableness.

For those unaware of what I am getting at, put it this way.

A relatively docile python pinned by the head with a snake stick and then grabbed by the neck is likely to be more agitated than if it is picked up calmly and handled mid body.

For the operated on snakes, this means that their handling in public displays for many years to come can be

less stressful for them and they are unlikely to be unduly agitated by repeated pinning and neck grabbing. For myself and the watching public, the risk of deadly bite is greatly reduced. An obvious question readers may have is, that if the operation to make Australian elapids "venomoid" is now so simple and easy, have I made all my elapids venomoid? The answer is "no".

Most snakes in my collection remain "dangerous" and have not been operated on.

Put simply there was no need to operate on them.

The snakes were not being used in public displays and at my own facility there is no risk of me or anyone else getting bitten.

The fact is that any half decent snake-keeper can use basic common sense and avoid a bite.

Notwithstanding this, I have no doubt that using the simple method outlined here, other keepers of deadly snakes will now avail themselves of the means to make their deadly snakes harmless.

FINAL NOTE

Critics may accuse me of writing as "pro-venomoid" paper and/or other claims may be made.

This paper is NOT "pro-venomoid", but reproduction of the fairly typical comments as posted on <http://www.kingsnake.com> and shown below under the heading "common misinformation" do show the sort of misinformation that abounds (this not being an attack on Jeff Barringer or Kingsnake.com itself, which is generally a very good forum).

This paper does however set out the facts in terms of a simple operation to make snakes venomoid, mainly so that others inclined to do such operations have a safe and reasonable template to operate under.

Yes, the operation is simple and claims to the contrary are simply not true.

It does not result in deaths and mass mortality as may be asserted by some (see below).

I have laid out a template for the venomoid operation so as to avoid butchering of snakes by persons who may otherwise not have knowledge of such procedures and inadvertently cause undue harm to snakes.

The venomoid procedure should not however be used by egomaniacs and other "tough-guys" who want an easy means to big-note themselves by supposedly taking risks handling deadly snakes that while apparently normal, are in fact harmless.

COMMON MISINFORMATION

The unedited posts below, illustrate the emotive misinformation that commonly occurs when venomoids are discussed in public forums.

Two posts (the entire thread) are printed below in unedited form to show how the information posted is contrary to the facts as detailed in this paper.

<http://forums.kingsnake.com/view.php?id=327264,327264>

Whats up with Venomoids?

Posted by: palex134 at Sun Jan 25 14:51:58 2004

Can someone please give me some information on Venomoids.

Peter Alexander

Coastal Herps Inc.

AND THEN

<http://forums.kingsnake.com/view.php?id=327264,328172>

RE: Whats up with Venomoids?

Posted by: calsnakes at Mon Jan 26 10:27:46 2004

As far as what? what it entails? it entails mutilating a perfectly healthy creature because you cannot take the time to learn to handle them right. It most likely kills more than survive.

END

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All photos by Raymond Hoser.

Raymond Hoser has been at the leading edge of herpetology (reptile science) for more than three decades. He's authored nine books, over 100 scientific papers and articles and had discovered and named several species of Australian and non-Australian reptile, including large venomous species and pythons.