FILLING IN THE CRACKS… SHELL FRACTURES IN TURTLES

DR SHANE SIMPSON

Dr Shane Simpson BVSc (Hons), GCM(VP), CMAVA
Karingal Veterinary Hospital
328 Cranbourne Road, Frankston, Victoria, 3199
P: 9789 3444
F: 9776 6127
E: info@thereptiledoctor.com.au
www.thereptiledoctor.com.au
www.facebook.com/TheReptileDoctor

Introduction

There are not many species of animal on the planet that can claim to carry their home on their back. Hermit crabs and snails do… and of course so do turtles. In fact the turtle's shell is quite literally what identifies them from other groups of animals. But carrying your home with you can create some problems… like what happens when it gets broken!

One of the most common problems seen in wild freshwater turtles across the country is shell injury. Treatment of these animals is unique given the complexities of turtle anatomy, semi-aquatic lifestyle and rate of healing. Wildlife carers need to develop a relationship with their veterinarian to ensure injured turtles are treated appropriately.

Anatomy

In order to properly treat turtles with shell fractures it is important to have at least a rudimentary understanding of their anatomy. While differences in size and shape occur across the species the basic anatomical arrangement of the shell remains the same.

The top part of the shell is called the carapace and the bottom part is called the plastron. These two sections are joined on either side by components referred to as bridges.

The shell itself is comprised of at least 50-60 bones from assorted locations such as modified front and rear leg bones, vertebrae and rib bones. The turtle's vertebral column is incorporated into the

carapace. Further support of the shell is achieved by the fusing of both the pectoral and pelvic girdles to both the carapace and the plastron.
The outer layer of the shell is composed of a layer of keratin arranged in a distinct pattern of scutes. The scute pattern is particular for a species and does not correspond to the underlying bones. This arrangement provides additional strength to the shell. Because the individual scutes can be named and numbered it allows any shell injury to be anatomically described with respect to location and severity.

Internally the shell is lined with pleurocoelom or coelomic membrane and several muscles also attach to the internal surface.

Causes of Shell Fractures
Shell fractures can be caused by a number of things. These include:
Motor vehicle trauma
Dog attack
Falls from heights
Boat propeller strike
Lawnmowers
Other trauma e.g. hailstones, humans etc.
Pathological fractures secondary to nutritional deficiencies, lack of UVB light and poor water quality.

Treatment from Beginning to End…
When presented with a wild turtle with a shell fracture all decisions that are made throughout the treatment should be based on one simple question… can this turtle be successfully released back into the wild? If the continuing answer is yes to this question then treatment should be pursued.
So how do I treat turtles with a shell fracture? Here is my 12 step approach:

Step 1
Assess for life threatening injuries. Look for any obvious injuries that would preclude it being treated. Examples would include head trauma, large shell deficits, loss of eyes, loss of multiple limbs, compound limb fractures, evisceration, inability to retract the head, paralysis of the hind legs indicating spinal trauma etc. If any of these are present then euthanase the turtle immediately.

Step 2
Stop any bleeding. It is possible for a turtle to suffer significant blood loss from shell fractures, particularly those involving the bridges. In addition there may be significant internal bleeding from organs such as the liver. A simple blood test called a PCV (Packed Cell Count) or haematocrit can be used to check for blood loss and monitor its progress.

Step 3
Radiograph the turtle. Three standard radiographic views are taken (dorsoventral, lateral and craniocaudal) to assess for bony fractures and to determine if the turtle is gravid. Injured gravid turtles should be medically induced. Particular attention should be paid to gravid turtles with pelvic fractures as the pelvic damage may prevent egg laying and surgery may be required to remove the eggs. Turtles with fractures of the long bones of the legs may heal with simple restraint but those with significantly displaced fractures may require surgery.

Some very lucky veterinarians may have access to a CT scanner. These machines allow for excellent assessment of shell fractures and internal injuries.

Step 4
Take some measurements. Knowing the weight of the turtle is important to allow for accurate drug dosage, fluid volumes and monitoring during the rehabilitation to be performed. A set of small digital kitchen scales that measure down to 1 gram are ideal. The turtle can be placed directly onto the scales or, if too active, a suitable container positioned on the scales.
Additionally measure the carapace length. This data can be used to correlate with bodyweight to assess the body condition of the turtle. In addition it can be used to gauge the approximate age of the animal.
Try and determine the sex of the animal.

Step 5
Provide analgesia. Reptiles in general are very good at hiding that they are in pain but we can safely assume a shell fracture would be painful. There is still much debate when it comes to the best drugs to use to provide pain relief in reptiles but more and more scientific

studies are being conducted. What is being shown is certain drugs work well in one species but may not work as well in another! Pain relief can be provided using three main classes of drugs. These are:

Non-steroidal anti-inflammatories: The most commonly used drug of this class used in reptiles is meloxicam. It is given at a dose rate of 0.2-0.5mg/kg orally or subcutaneously every 24-48 hours for 4 to 10 days.

Opiates: There have been several types of opioids used in reptile medicine including morphine, buprenorphine and tramadol. The author's preferred opiod to use in turtles with shell fractures is butorphanol at a dose rate of 4mg/kg subcutaneously every 12-24 hours for 3 days. Note this dose is considerably higher than is reported in many texts and formularies.

Local anaesthesia: The use of local anaesthesia is an often overlooked method of providing pain relief to turtles with shell fractures. Drugs such as lignocaine can be dripped along the fractures edges to provide temporary pain relief. Toxicity can be an issue so no more than 6mg/kg should be used.

The ideal method of providing pain relief is to use a multimodal approach where all 3 classes of drug are used.

Step 6

Provide temporary stabilisation of mobile shell fragments. The most painful part of any fracture in any animal is when fragments are unstable. This applies just as much to shell fractures as it does to broken limbs. Unstable fragments will also not heal. Because of this it is beneficial to try and prevent as much movement of fractured shell fragments as possible. This can be achieved by using adhesive tapes and light bandages such as VetWrap. These can be easily removed if necessary to allow cleaning of wounds and more permanent shell stabilisation to be performed when required.

Step 7

Assess temperature and provide warmth if required. Many wild turtles are brought in by members of the public after they have been found on the road or beside the road. It is often unknown how long they have been there. Our first instinct as animal carers is to provide

heat but this may not necessarily be the best first course of action. A core body temperature should be taken using a small digital thermometer placed in the cloaca. A turtle that has been struck by a car may have been sitting on a hot road for a period of time and may in fact be suffering from heat stress. The last thing it needs is to be provided with supplemental heat!
If heat is needed it can be provided by using a number of commercially available products such as heat mats, heat cables and heat lamps. Warmth should be provided within the turtle's preferred body temperature range.
If cooling is required then this can be achieved by water baths, fans etc.

Step 8
Give supportive fluid therapy. Turtles suffering a recent shell fracture are likely to be in a state of shock. In general animals suffering from shock have low blood pressure and can develop poor provision of oxygen to organs (i.e. poor perfusion). As such they can benefit from fluid therapy as can those animals with any level of dehydration.

If the shell injuries are confined to the upper carapace only the turtle may be placed in a shallow bath of warm water (25°C) for 10-20 minutes. This will give the turtle sufficient time to drink. It is important that the water level does not reach to the level of the wounds and that the turtle is observed closely to ensure it does not try to climb out, tip over and expose the open shell fracture to water. This method should not be used in animals showing signs of head trauma as they may be unable to lift their head from the water and therefore possibly drown.

Fluids should be warmed to the animal's preferred body temperature prior to administration.
Oral fluids can be given at a rate of 25-40mls/kg bodyweight/day using a stomach tube.

If necessary, parenteral fluids can be given intravenously, subcutaneously, intraosseously or intracoelomically. Some studies have shown though that fluid given intracoelomically may not be well absorbed.
The author's preferred method route is intravenous. IV fluids can be given at a rate of 5-10mls/kg as a bolus injection or alternatively a continuous rate of 1ml/kg/hour can be given using an infusion pump.

There are several “recipes” for creating fluids for reptiles. A commonly used parenteral fluid combination is a mixture of 1 part Hartmann’s solution to 2 parts 0.45% NaCl + 2.5% glucose. Alternatively a mixture of 9 parts 0.9% NaCl and 1 part sterile water for injection can be used.
In cases of severe blood loss a blood transfusion can be performed.

Step 9
Start antibiotic therapy. Antibiotics may be required for 2 weeks prior to any attempts to repair a shell fracture.

The most commonly used antibiotic in reptiles by veterinarians in general practice would be enrofloxacin. The most common trade name for this drug is Baytril though there are now generic brands available. This can be given orally or subcutaneously at a dose rate of 5mg/kg every 24 to 48 hours for 7 treatments. Enrofloxacin has 2 main drawbacks. Firstly it is not very effective against a group of bacteria called anaerobes and these are often found in contaminated wounds such as shell fractures. For this reason it is often best to combine the use of enrofloxacin with another antibiotic called metronidazole. This is given orally at a dose rate of 40mg/kg once daily for 7-10 treatments. The second issue with enrofloxacin is that the injectable form can cause severe pain and tissue damage at the site of injection. For this reason it should be diluted 1:2 to 1:10 with sterile water for injection and injected into alternating sites.

Veterinarians that see a reasonable number of reptiles in their practice may have the antibiotic, ceftazidime on their shelves. The trade name for this drug is Fortum. It has excellent activity against a wide range of bacteria and need only be given via an intramuscular injection every 3 days. The downside is that it is comparatively expensive. It comes as a freeze dried powder that must be reconstituted with sterile water. Once made up the solution must be kept frozen or it will inactivate. The dose for ceftazidime is 20mg/kg intramuscularly every 72 hours for 7 to 10 treatments.

Step 10
Treat the wounds. Shell fractures should be treated as open, contaminated wounds. As such they should thoroughly cleaned and

free from any debris and infection before any attempt to stabilise or close the fracture is made.
Wounds can be flushed with warm saline, 0.05% chlorhexadine or 0.1% povidone iodine 1 to 3 times a day depending on the level of contamination. Ensure that contaminants are not being flushed into the body cavity.
Between flushings the use of wet-to-dry bandages can be used to remove further contaminants. These can be as simple a gauze swabs soaked in saline or chlorhexadine, applied to the wounds and bandaged in place. Other products that can be used include Flamazine cream, Solusite Gel and Manuka honey.

Any surface material should be gently removed using cotton tips or a soft toothbrush. It is not necessary to clean the entire shell but it will reduce the potential level of contamination of the wounds during treatment. It is also not necessary to remove all the algal growth off the shell that some turtles have. It should however be removed from near the fracture sites and anywhere else deemed necessary. Wound care may initially be needed each day.
Wounds to the shell may require debridement of dirt and dead tissue as this will slow healing. If significant debridement is required this should be done under general anaesthesia. Shell fractures can be scraped clean using hypodermic needles, scalpel blades, hand dental curettes or even high speed dental drills. Shell edges should be debrided to the point of achieving capillary bleeding as this indicates viable tissue. Depressed fragments should be lifted back into place. If this is not possible then the overlapping shell fragment should be cut back to the level of the underlying fractured segment's edge. This will allow healing to occur between two fresh edges.
Missing areas of shell can be covered with waterproof dressings such as Opsite and Tegaderm.

Step 11
Stabilise the shell. There have been many different methods used to repair the shells of turtles. They all have their positives and negatives.

Some important points to remember:
Most shell repairs should only be performed on anaesthetised animals. Details of this are beyond the scope of this presentation.
There does not need to be a complete reduction of broken fragments for it to heal but the closer the fragments the better.

Shell fractures can take up to 30 months to fully heal.
Spaces left between fragments will heal via ossification of the coelomic membrane.
Most shell fractures should be treated as open wounds.
The art to repairing a shell fracture is to know what repair method to use when!

Techniques include:
Adhesive tape
Curtain hooks
Thermoplastic braces
Stainless steel pins and Knead It

Irrigation saddle clamps. These can be fixed onto the shell using epoxy resins. They can be easily bent and shaped to fit. They also allow for easy cleaning under the "U" section. Disadvantages include that they protrude from the shell and are flexible so may not provide very good stability on particularly mobile fragments.
Screws and wire. This method is used to stabilise mobile fragments and is considered by many as being the best method. It can involving simply using stainless steel wire through to more complex reconstruction using orthopaedic screws, wire and metal bridging braces.

Cable ties: Cable ties can be used in assortment of ways to stabilise fragments. They can be fixed to the shell using epoxy resins or Knead It. Alternatively they can be placed through small holes drilled through the shell. They have the benefit of being cheap, inert and requiring no special equipment.

Glass ionomers: This material is what is used in human dental fillings. They contain silicate cement and release fluorine to provide local antibacterial effects and increase calcium deposition into the healing shell. They should only be used on sterile wound sites and are suitable for stabilising and sealing shell cracks rather than large fragments. A trough is cut along the crack using a high speed dental burr or engraving tool. The area is well cleaned to remove any debris that is created and allowed to dry. The dental glass ionomer is applied to the area and allowed to set.

Vacuum-assisted healing: This is a human wound management technique that has been applied to turtle shell defects in an effort to

speed up healing. Wounds are packed with a sterile foam dressing and covered with a transparent adhesive dressing. A tube is placed through the dressing and into the foam. This is connected to a machine that provides 24/7 suction.

Epoxy resins and fibreglass: Historically this was the method of choice but it is now considered an inappropriate way to repair shells for a number of reasons:
These materials are extremely toxic to living tissues and leakage of them into wounds can cause severe damage;
When setting these material often release a significant amount of heat that can further damage tissues;
Covering wounds with these materials can trap debris and infection resulting in abscessation and septicaemia developing.

If used on immature turtles it can lead to distortion of shell growth.
They prevent natural shedding of scutes which may become a source of water entrapment at the edge resulting in subsequent shell rot.

Step 12
Rehabilitation and release: During the rehabilitation of a turtle it is important to keep good records. Specifically body weight, activity levels, feeding behaviour and any other observations should be recorded. Everything tends to happen slowly with turtles and so changes for the worse can happen over a period of weeks and can be easily missed.

Turtles must be provided with adequate warmth and the ability to carry out thermoregulation. This can be achieved by creating a thermal gradient in their enclosure by using a basking lamp or heat mat placed at one end. Additionally species that require UV light should have access to this whether it is provided by artificial light or the sun.

Fully immersing turtles with shell fractures in water is generally not recommended as this may increase the risk of infection at the fracture site or cause water to leak into the body cavity if the coelomic membrane is torn. As such it may be necessary to “dry dock” turtles in the initial stages of shell healing. While this may only be required for a little as 2 weeks in some turtles with minor fractures it may be for as long as 1 to 2 years in very complicated fractures. Determining when it is safe to allow a turtle to go back in

the water may not be an easy thing and is based on experience and the presence of adequate healing over the fractured area.

Dry docking comes with some problems. Turtles need to be in water to drink and feed. Dry docked animals also run the risk of developing plastral pressure sores and so should be housed on soft bedding such as shredded newspaper.

There are considered to be 3 levels of dry docking. They are:
Full water immersion. This method is suitable for turtles with small fractures that can be covered with waterproof dressing such as Opsite. Turtles are allowed to swim in full water for 30 to 60 minutes per day.

Partial water immersion. This can be used for turtles with fractures confined to the carapace where the water level is below the position of the fractures. Again turtles are allowed access to this water for 30 to 60 minutes per day.

No water immersion. Turtles with bridge fractures, plastron fractures or minor head injuries may need to be totally dry docked for a period of time.
If dry docking is only to be for a short period of time (2 to 4 weeks) and the animal is in suitable body condition then feeding may not be required. Fluid therapy can be given via the routes mentioned previously. If feeding is to be required it can be performed in one of three ways:

Stomach tube: This involves passing a tube down into the stomach to allow the placement of fluid and food. The tube is removed and the process repeated each time the animal requires it. This method can be stressful for the animal and can become increasingly more difficult as the turtle becomes stronger.

Oesophagostomy feeding tube: Under general anaesthesia a feeding tube is placed. This can make feeding, hydrating and medicating the turtle much easier.

"Turtle Steamer": The turtle is housed in an enclosure with a raise bottom. A "sunken" water source is provided so that the turtle is only able to place its head and neck into it to eat and drink.

Foods that can be used include Hills A/D, Oxbow Critical Care Herbivore and Wombaroo Reptile Supplement. Recovering turtles can be fed 3% of their bodyweight every other day alternating with water given at 25mls/kg.

References

Bogard C. and Innis C. A Simple and Inexpensive Method of Shell Repair in Chelonia. Journal of Herpetological Medicine and Surgery 18 (1): 12-13

DeSouza R. Comparison of Therapeutic Protocols Used for Shell Wound Repair in Red-eared Sliders. Exotic DVM 7.5: 53-57

Fong R. Modern Shell Fracture Repair in Chelonians. Annual Project. University of Melbourne Veterinary School, 2013.

Forrester H. and Satta J. Easy Shell Repair. Exotic DVM 6.6: 13

Fowler A. and Magelakis N. Shell Fracture Repair Using Glass Ionomer Cement in the Long Neck Turtle (Chelodina longicollis). UEP Proceedings 2004.

Johnson J. How to Repair Chelonian Shell Disruptions. Western Veterinary Conference, Las Vegas. 2002

Johnson R. and Roffey J. An Anatomical Approach to Prognosis in Traumatic Injures of the Common Eastern Long-necked Turtle. AAVAC-UEP Proceedings 2006

Kishimori J. et al. Chelonian Shell Fracture Repair Techniques. Exotic DVM 3.5: 35-41

Lloyd C. Alternative Method for Cable Tie Shell Repair in Chelonia. Exotic DVM 9.3: 9-10

Simpson S. 4 Vets and a Turtle. UEP Proceedings 2008

Valiente S. Bone Pin Staples for Tortoise Shell Repair. Exotic DVM 9.3: 11-12

Vella D. Management of aquatic turtle shell fractures. In CVE Wildlife Proceedings 371: 241-273

A Treatment And Hospital Care Chart for the management of injured turtles is available at www.thereptiledoctor.com.au and searching "turtle treatment chart".

DR SHANE SIMPSON: As a veterinarian with a special interest in reptiles and amphibians, Dr Shane Simpson is probably better known as "The Reptile Doctor". Each year he treats over 2000 pet and wild reptiles at Karingal Veterinary Hospital located in the south-eastern suburbs of Melbourne.

Dr Simpson regularly lectures to fellow veterinarians, veterinary nurses and reptile keepers on assorted topics relating to reptile and amphibian medicine and surgery. In addition he regularly contributes articles and other material to reptile magazines, veterinary journals and websites as well as being an active participant on several online forums and Facebook pages dedicated to reptiles and amphibians. He is a consultant veterinarian for a number of reptile shops and aquariums, wildlife shelters, reptile demonstrator businesses, wildlife parks and large commercial collections. Dr Simpson is a member of the Australian Veterinary Association, The Unusual and Exotic Pet and Avian Vet Association, the Association of Reptile and Amphibian Veterinarians and the Victorian Herpetological Society.