Wild turtles and tortoises are widely distributed in North America, and both wild and exotic species continue to be popular pets. Unfortunately, chelonian interactions with the world of humans are a frequent source of trauma, including both orthopedic (shell, limb, and maxillofacial fractures) and various forms of soft tissue trauma. General practitioners should be equipped to deal with these emergencies when they are presented. Not much specialized equipment is needed, and chelonian patients, although challenging, are also very rewarding to treat. This article outlines the essentials of trauma management in chelonian patients based on the current literature and the authors’ practice experience, which includes a regular flow of chelonian trauma cases each spring and summer.

DIAGNOSTIC CRITERIA

**Historical Information**
- Patients are presented as injured wildlife or pets.
- Exposure (known or surmised) to motor vehicle, dog, lawnmower, or the like.
- Wildlife cases often peak in mid-spring when turtles and tortoises are most active and likely to cross roads.

**Physical Examination**

**Principles**
- Slow, gentle traction so as not to frighten or stress the patient. Forceful traction can result in rhabdomyolysis.
- Do not flip the patient over on its back to examine and/or treat—this is highly stressful.
- Grasp the head behind the mandibles to control and/or examine the head and neck—you have only one chance to secure the head.

**Sedatives and Anesthetics for Examination and Treatment**
- Chemical restraint is often necessary to facilitate examination or treatment, but remember that very sick or debilitated chelonians are often at substantial risk for mortality when sedatives or anesthetics are used.
- Use good judgment to determine whether the risk is higher from the stress of handling a fully awake patient or from sedating or anesthetizing a debilitated animal.
- Guidelines to indicate that a patient may be at excessive risk from sedation or anesthesia include:
  - Very low heart rate (<15 beats per minute) with the patient at optimal temperature (Doppler flow monitor is useful but expensive). $$$
  - Very low packed cell volume (PCV; <10%) or total plasma (TP) solids (<2.0 g/dl).
  - Sepsis (see below).
  - Severe starvation or dehydration (a very “light” turtle that feels like a hollow shell with almost nothing inside).
- Suggested drug protocols for chemical restraint:
  - Ketamine (5–8 mg/kg IV) with medetomidine (50–100 µg/kg IV). The authors have also used this protocol IM with good results.
  - Ketamine (40 mg/kg IM) with midazolam (2 mg/kg).
  - Tiletamine–zolezepam (Telazol, Fort Dodge Animal Health, Fort Dodge, IA; 10–20 mg/kg IM).
  - Propofol (5–15 mg/kg IV to effect; re-dose approximately q5min).

**Deep Soft Tissue Trauma**
- Most serious, yet most easily overlooked.
- Vehicular trauma most likely to cause serious deep trauma.
- Can have trauma in one or more of the following:
  - Pulmonary organs (lung lacerations).
  - Parenchymatous organ (liver fracture).
— Hollow viscus (intestinal or bladder rupture).
• Often is the underlying cause of patient mortality.

Superficial Soft Tissue Trauma
• Ocular trauma.
• Skin lacerations or maceration.

Orthopedic Trauma
• Shell trauma.
• Limb trauma.
• Maxillofacial or skull fractures.

Neurologic Trauma
• Close apposition of spinal cord to carapace makes spinal cord trauma common in patients with mid-dorsal carapacial fractures.
• Chelonian neurologic examination:
  — Look for hindlimb paralysis.
  — Chelonians respond to noxious stimuli by withdrawing limb(s) or attempting to escape or bite (except tortoises often do not attempt to bite).
  — Gait, placing, and righting can also be evaluated, although righting is often not appropriate to test in a chelonian with shell fracture.
  — Jaw and muscle tone can be evaluated when performing an oral examination.
• Neurologic trauma is a negative—but not hopeless—prognostic indicator. Some chelonians with displaced dorsal carapacial fractures and hindlimb paralysis have regained neurologic function in time.
• Ruptured colon with subsequent coelomitis is a potential fatal complication of spinal trauma; it may take weeks to manifest. Chelonians with spinal trauma should be monitored for defecation while awaiting return of ambulation, and owners should be warned of this potential.

Secondary Consequences of Trauma
Dehydration
• May occur fairly rapidly because of blood and fluid loss at the time of trauma and afterward, and an animal that presents in a dehydrated condition may be in a state of hypovolemic shock, a common and life-threatening sequela.
• Eye position (sunken) and skin turgor (tented).
• PCV and TP increased from previous samples or species norms.
• Weight loss—Hospitalized chelonians should be weighed daily. Weight loss is much more likely to be from dehydration than loss of tissue mass. Daily weight changes correlate directly with fluid loss (10 g acute weight loss roughly equals 10 ml fluid loss) and can be used to help guide fluid therapy.
• Thick, viscous oral secretions—Note that normal oral secretions of chelonians are somewhat thicker and more viscous than in dogs and cats; familiarity with chelonians gained through repeated physical examinations can enable veterinarians to differentiate the normal from the abnormal.
• Lack of urination—Although not a pathognomonic indication of dehydration, lack of urination, especially in patients that normally urinate frequently (e.g., water turtles) and have previously been seen passing urine, may be an indication of dehydration and should be part of the overall hydration assessment when applicable.

Infections and Parasitism
• Necrotic odor.
• Exudates.
• Plaques of fungal hyphae.
• Indications of sepsis:
  — Petechial hemorrhages of the skin, oral mucous membranes, or scutes (especially the plastral scutes).
  — Hyperemic oral mucous membranes (dark red-purple).

External Parasitism
• Myiasis (fly strike):
  — Two types are frequently seen in wild turtles: maggot infestation of wounds (e.g., blowflies [Phaenicia spp, Lucilia spp]) and bot fly infestation (flesh flies [Sarcophaga spp]).
  — Fly maggots may be seen in wounds as recent as 24 to 48 hours old. Maggots may actually be beneficial for debridement of wounds if a large amount of necrotic tissue is present. Application of pesticides is contraindicated, so gentle removal by flushing with sterile saline is best.
  — Bot fly infestation is the infestation of healthy tissue by parasitic fly larvae, which form nodules under the skin from which the pupae later emerge. A small, dark “breathing hole” is usually evident in the middle of the nodule. Bot fly infestation is treated by making a small incision over the nodule and removing the maggots or pupae with forceps.
• Ticks may also be found on wild chelonians and are a potential cause of significant blood loss and stress. Remove gently with forceps.

Internal Parasitism
• External signs may vary from ill thrift and diarrhea to inappetence.
• Diagnosed via fecal examination.
**Shock**
On presentation, a chelonian in shock may be weak (normal chelonians are incredibly strong for their size), have an abnormally rapid or slow heart rate, or be unresponsive to stimuli (e.g., toe pinch, attempts to examine the mouth or place an intravenous catheter) that would normally evoke an escape response.

**Laboratory Findings**
- **PCV**—Normal range for most tortoises is 20% to 40%. A wide range of normal values is reported for chelonians; because of this, it is best to use normal values for the species being treated.
- **TP**—Again, normal range (3.0 to 6.0 g/dl) is high. Use normal values for the species being treated.
- **Fecal examination**—Flotation and direct smear to evaluate for internal parasitism.
  - Nematode and protozoan parasites can be fairly common in both wild and captive chelonians.
  - Use references to aid in identification.
  - Treatment of all internal parasitism is usually recommended to reduce stress.

**Other Diagnostic Findings**

**Radiography**
- Lateral and craniocaudal views—Use horizontal beam (preferred because tissues and fluid do not shift position) or vertical beam (place patient in an appropriately sized cardboard box and wedge in place with foam).
- Useful for assessment of:
  - Limb fractures and depressed (intracoelomic) shell fragments.
  - Pulmonary abnormalities, including trauma and pneumonia—Look for increased radiopacity and asymmetry in lung fields.

**Endoscopy**
May be a useful, minimally invasive way to assess intracoelomic trauma, which may allow a more accurate prognosis. Major intracoelomic trauma is often otherwise difficult to diagnose and may be a significant cause of mortality. A sterile or disinfected otoscope cone may suffice in smaller chelonians for this.

**Summary of Diagnostic Criteria**
- Known or suspected history of trauma.
- Presence of external wounds.
- Internal wounds may also be present and be more severe than the external ones.

**Diagnostic Differentials**
- **Limb fractures**—In captive chelonians, pathologic fracture from nutritional secondary hyperparathyroidism can occur; such animals nearly always are juveniles and have a soft or deformed shell.
- **Pneumonia**—May be secondary to trauma or a sign of respiratory disease from other etiologies (primary pathogens or secondary pathogens with immune suppression).
- **Weight loss**—May be secondary to trauma or from other etiologies (e.g., infection, parasitism, poor nutrition).

**TREATMENT RECOMMENDATIONS**

**Initial Treatment**
Initial treatment consists of four steps: Treat for shock, decontaminate open wounds and prevent recontamination, initiate appropriate antimicrobial treatment, and rewarm the patient.

**Treat for Shock—Fluid Therapy**
- **Intracoelomic (ICe) route:**
  - Least stressful for patient and easiest for clinician; this is the preferred route for initial stabilization of most patients.
  - Contraindicated when lungs or air sacs are not intact.
  - Insert 28- to 25-gauge \( \frac{5}{8} \)-inch needle through the soft skin just cranial to the hindlimb.
- **Intravenous (IV) route (via the jugular vein):**
  - Preferred route of fluid resuscitation when patient presents in a very shocky, weakened (unresponsive) state.
  - Access via cut down; incision should be made in the rostrocaudal direction rather than the dorsoventral.
  - Jugular veins are located superficially and dorsal to the dorsoventral midline of the neck, in line with the dorsal edge of the tympanum. Right jugular is often larger than left.
  - Ordinary IV catheters (24 to 22 gauge) work fine; patency is maintained even when the head and neck are withdrawn into the shell.
- **Intraosseous (IO) route:**
  - Bridge between carapace and plastron.
  - Tiny K-wire (0.035 to 0.045 inch) or 1.0-mm drill bit to gain access.
  - Short (\( \frac{5}{8} \)-inch) needle (25 gauge [for small turtles] up to 20 gauge [for large turtles]) is glued in place with cyanoacrylate.
  - Spinal needle not necessary; if hypodermic needle becomes plugged on insertion, simply replace it with another one.

**STANDARDS of CARE: EMERGENCY AND CRITICAL CARE MEDICINE**
• Subcutaneous route:
  — Use when ICoE route is contraindicated and IV or IO route is not needed or is inaccessible.
  — Inject fluids into flank fold using a small needle (same sizes as for ICoE administration).
• Suggested fluid rates for chelonians:
  — IV or IO routes: 0.5–1.0 ml/100 g/hr for resuscitation or surgery.
  — ICoE route: 1.0–2.0 ml/100 g/injection; usually repeat q8–24 hr.

Decontaminate Open Wounds and Prevent Recontamination
• Gentle, thorough lavage with isotonic fluids, ±1:40 chlorhexidine gluconate (do not use chlorhexidine in cases of spinal trauma with exposed cord).
• Major challenge is preventing contamination from being washed deeper into the turtle’s body. This may be one time when tilting the patient to put the shell defect down (briefly!) is desirable. If there is already deep contamination of the coelom, lungs, or air sacs, it may be best not to lavage.
• Standard open wound care techniques are appropriate. Wet-to-dry gauze bandaging is usually effective and is easily performed; broad-spectrum (antibacterial/antifungal) topical agents (e.g., silver sulfadiazine) may also be used.

Initiate Appropriate Antimicrobial Treatment
• Traumatic wounds are usually contaminated with mixed microbial flora, including fungi and gram-positive and gram-negative bacteria.
• Broad-spectrum antimicrobial treatment is indicated because any isolate may potentially be pathogenic in devitalized tissues or immunocompromised patients.
• Most drug doses are still empirical in reptiles; research recent literature for most current dosing recommendations.
• Antibacterials:
  — Enrofloxacin (5–10 mg/kg IV or ICoE, diluted to 10 mg/ml in 0.9% NaCl, q48h).
  — Ceftazidime (20–30 mg/kg IV, ICoE, or IM q48h).
  — Ceftriaxone (5 mg/kg IV, ICoE, or IM q24h).
  — Metronidazole (20 mg/kg IV, ICoE, or PO q48h).
• Antifungals—Prophylactic use is recommended with any wound requiring long-term antibiotic therapy (more than 2 weeks) and especially if coelomic cavity or organs are exposed to environmental contamination (fungal pneumonia is a major threat).
  — Fluconazole (20 mg/kg ICoE q7d).
  — Ketoconazole (15–25 mg/kg PO q24h).

Rewarm Patient to Physiologic Range
• Preferred optimum temperature zone (POTZ) for most North American species is approximately 78 to 88˚F; species variation exists, however, and a good herpetologic library is helpful.
• Tortoises—A common misconception is that chelonians from arid climates need a very hot, dry environment. This is not true; these animals are usually underground, where the microenvironment is considerably cooler and more humid than on the surface during the hot periods of the day (or year).
• Increases in temperature (above normal room temperature) must be made gradually (over 1 to 2 days) and only after initial stabilization, decontamination, and initiation of antimicrobial treatment have been accomplished. Rapid rewarming of an unstable chelonian can be fatal.

Definitive Treatment
Soft Tissue Trauma
Ocular Trauma
• Manage as you would ocular trauma in other small animals:
  — Topical ocular anesthetics may facilitate examination and treatment.
  — Removal of foreign material via saline flush or gentle manual removal.
  — Appropriate topical treatment for conjunctivitis or corneal injuries.
  — Temporary tarsorrhaphy may be indicated to protect the injured eye.
• Because chelonians have remarkable healing capacity and may eventually recover from severe ocular trauma, even apparent blindness, do not enucleate unless necessary to treat an orbital infection.

Lacerations
• Managed the same as any other contaminated wound.
• Closure—Reptile skin is naturally inverting, resulting in scale–scale contact. Use an eversion pattern (e.g., horizontal or vertical mattress sutures).

Orthopedic Trauma
Fracture Repair $$$–$$$$
• Long bone fractures are relatively uncommon.
• External coaptation (taping limb into shell) is unsatisfactory (delayed union or nonunion).
• Plating with a 1.5- to 2-mm veterinary cuttable plate, finger plate, or maxillofacial plate seems to work best.
• Amputation is also an option.
Amputation
- Indicated for irreparable soft tissue, nervous system, or orthopedic trauma.
- Well tolerated, particularly single hindlimb amputations.
- Distal amputation:
  — Permissible and even advisable on chelonians with trauma limited to distal limb.
  — Stump trauma is usually not a problem if a flap of thick, scaled skin is used to cover the amputation site.
  — Allows near-normal ambulation if most of the limb can be preserved.
- High amputation (proximal trauma):
  — A rounded, smooth object may be glued to the plastron at the corner with the amputated limb. This serves as a skid, protecting the plastron from abrasion and allowing a more normal gait.

Shell Fractures

Epoxy and/or Fiberglass Patches $\$$
- In recent years, there has been a move away from the use of epoxy and/or fiberglass patching. Other techniques (interfragmentary wiring, shell plating) have become the standard for shell repair.
- Contraindicated in water turtles.
  — These species shed the skin over their scutes.
  — Fiberglass covering the shell causes shell necrosis and sepsis.
- Patching is contraindicated with open, contaminated shell fractures, or when pieces are missing.
  — Fiberglass patching seals in contamination and prevents normal drainage.
  — Open wound management is indicated until granulation tissue fills in the defect.
- Daily bandage changes are required to keep the wound from drying out.
- Risk of patient dehydration from fluid loss through the wound.

Interfragmentary Wiring $\$$
- Can be performed under sedation (see Suggested drug protocols for chemical restraint, page 7).
- Tiny holes can be drilled in the shell fragments with a small bit (1.1–1.5 mm) or K-wire (0.045 or 0.062 inch).
- Orthopedic wire (24 gauge in patients weighing 200 g or less; up to 20 gauge in patients weighing 5 kg or more).
- Holes placed about 3 mm from fragment edge, usually two holes per side of each fragment.
- Freer periosteal elevator and needle holders are useful for manipulating fragments and wires.
- Drill holes and place all wires before tightening any of the wires.
- Tighten wires beginning at the most central fracture and work outward toward the marginal scutes—this may allow a broken wire to be replaced.

Shell Plating $\$$--$$
- Mini plates (finger, maxillofacial, reconstruction) can be used.
- Requires plating instrumentation and inventory.
- Stable, anatomic reduction is achievable.
- After reduction with wire and/or plates, a narrow (4- to 6-mm) bead of 1-minute epoxy can be used to seal the shell if the wound is completely free of contamination or if granulation tissue is visible deeper and no exudate is present.
  — Care must be taken to keep epoxy on top of the cracks and not to get any into the cracks.
  — Sterile lube, hydrogel, or hydrolyzed collagen dressing may be placed in small cracks and voids to keep out the epoxy.
  — The epoxy seal reduces ongoing fluid losses, protects against environmental contamination, and speeds return of water turtles to an aquatic environment.
  — The authors have not noted deleterious shell effects with this practice.

Postoperative Pain Management
- Chelonians respond appropriately to noxious stimuli; therefore, we must assume they feel pain.
- Very limited and largely anecdotal information exists about reptile pain management (e.g., opioid receptors are known to exist, but their role is uncertain).
- Butorphanol tartrate (0.4–0.8 mg/kg) has been recommended for analgesia in chelonians. Efficacy is uncertain, but this drug may be useful and is not known to be harmful.

Supportive Treatment

Environmental Controls
Highly important in all reptiles. Especially critical for injured reptiles because they are already stressed and have reduced adaptive capacity.

Temperature
- Maintain in the upper end of the POTZ:
  — Improves immune function.
  — Allows more rapid wound healing.
— Higher metabolic rate improves drug pharmacodynamics and pharmacokinetics.
- Cannot rely on patient behavioral thermoregulation; therefore, temperature gradients are inappropriate. Patient must have uniform temperature.

**Humidity**
Humidity control may become an issue if a water turtle is being kept landlocked for an extended period for wound healing. If the environment is too dry, the patient may become dehydrated.

**Nutritional Supplementation**
- Most turtles or tortoises with major trauma will probably require an esophagostomy tube. It can be placed (with the patient under sedation) at the same time as catheterization or shell repair.
- Feeding should never be initiated until after the patient has been stabilized and temperature has been restored to the POTZ.
- Recommended feeding supplements for esophagostomy tube feeding:
  - **Tortoises**: Mixed vegetable or vegetable and fruit baby food; strained mashed alfalfa pellets are also good if the feeding tube is large enough to prevent the pellets from plugging the tube.
  - **Box turtles**: Same as for tortoises with the addition of turkey baby food or mashed strained earthworms (25% to 50% of diet).
  - **Water turtles**: Mixture of strained mashed earthworms and turkey baby food (75% to 80% of diet) and mixed fruits and vegetables.
- A line of powdered dehydrated diets, formulated by a veterinary nutritionist specifically for reptiles, is also available (see Resources, page 13).

**Antiparasite Therapy**
- Suggested drugs and doses:
  - Fenbendazole (50–100 mg/kg PO q48h for three doses; repeat in 3 weeks) for anthelmintic treatment.
  - Iodoquinol (10–50 mg/kg PO q24h) for entamoebiasis.
  - Praziquantel (8 mg/kg IM once; repeat in 3 weeks) for cestodes and trematodes.
  - Sulfadimethoxine (90 mg/kg once; then 45 mg/kg PO q24h) for coccidians.
- Ivermectin is toxic to some chelonians and should never be used in box turtles or tortoises.

**Patient Monitoring**
- Activity level.

- Appetite (may be slow to return).
- Wound appearance:
  - Exudation.
  - Odor.
- Hydration status—Very important, especially in patients with an open shell wound being managed for second-intention healing.
  - Sequential PCV and TP.
  - Weigh patient daily on a gram scale.

**Home Management**
- Owners or wildlife caretakers must be extremely attentive to all aspects of husbandry during the recovery period.
- The convalescent care requirements often create a substantial time burden on owners or caretakers and may continue for months. This aspect of the “cost” of treatment should be thoroughly explained before veterinary care is instituted.
- Owners must provide optimum environment (temperature, humidity, isolation from other chelonians, “dry-docking” of nonsealed water turtles).
- Nutritional support:
  - Resumption of normal feeding is a high priority.
  - Daily or every other day feeding via esophagostomy tube may be required, sometimes for a prolonged period.
  - Availability of water, even placing the turtle or tortoise into a shallow pan of water, does not necessarily ensure adequate hydration.
  - If the patient is not observed to be voluntarily eating on a regular basis and/or exhibits any signs of dehydration, water or a hypotonic balanced electrolyte solution (e.g., half-strength lactated Ringer’s solution) must be administered orally or via a feeding tube.
- A sick or injured chelonian must not be allowed to hibernate—It will die. Provision must be made for overwinter care.

**Milestones/Recovery Time Frames**
- Return of normal appetite and activity level are two reliable early indicators that recovery is progressing well.
- Soft tissue healing takes place fairly rapidly: Skin sutures are usually removed 30 days postoperatively.
- Bone healing is much slower: 2 to 6 months for limb fractures and 6 to 24 months for shell fractures have been reported.
PROGNOSIS

Favorable Criteria

Pretreatment
- Active patient with no apparent locomotor deficits.
- Shell trauma limited to marginal scutes; no pieces missing, minimal to no displacement.
- No contamination of coelom.

Posttreatment
- Rapid return to normal activity and appetite.
- For open or second-intention wounds, rapid resolution of wound drainage and formation of granulation tissue.

Unfavorable Criteria

Pretreatment
- Massive shell trauma with missing pieces or heavy contamination.
- Major dorsocranial shell trauma (lung involvement).
- Spinal trauma.
- Extremely weak, unresponsive patient at admission.

Posttreatment
- Slow return to normal activity level; unusually slow recovery from sedation or anesthesia.
- Prolonged anorexia.
- Development of secondary problems (e.g., pneumonia).
- Wound indicators:
  - Lack of granulation tissue formation.
  - Secondary wound infections (bacterial or fungal; may see mycelial plaques).
  - Necrotic odor from wound.

RECOMMENDED READING


RESOURCES

- Ultrasonic Doppler flow detector—Model 811-B, Parks Medical Electronics, Inc., 19460 S.W. Shaw, Aloha, OR 97007. $$$