Surgical Management of Maxillary and Mandibular Fractures in an Eastern Bluetongue Skink, *Tiliqua scincoides scincoides*

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ABSTRACT: A free-ranging, adult female eastern bluetongue skink, *Tiliqua scincoides scincoids*, was presented to the Australian Wildlife Health Centre with multiple skull fractures secondary to presumed road trauma. Fracture reduction and stabilization was accomplished using a combination of non-absorbable suture material and an intramedullary pin. Fracture healing was complete by three and a half months post surgery and the animal was subsequently released at the capture point.

KEY WORDS: eastern bluetongue skink, *Tiliqua scincoides scincoides*, intramedullary pin, fracture, mandible, orthopaedic

INTRODUCTION

The eastern bluetongue skink, *Tiliqua scincoides*, is a large terrestrial skink that can reach total lengths of up to 56 cm. This species ranges from the far north of Australia, down the eastern seaboard, extending into southern Victoria and South Australia (Cogger, 1975, Ehman, 1992). In general eastern bluetongue skinks are characterized by a thick, robust body with seven to nine dark cross-bands that traverse the dorsum and continue the length of the tail (Cogger, 1975, Ehman, 1992). The eastern bluetongue skink is the largest of the bluetongue species and can be further differentiated into two distinct subspecies, the eastern bluetongue skink, *Tiliqua scincoides scincoides,* and the northern blue-tongued skink, *Tiliqua scincoides intermedia,* based on geographical location and minor differences in coloration (Cogger, 1975, Ehman, 1992).

Figure 1. Transverse mandibular fracture in an eastern bluetongue lizard, *Tiliqua scincoides scincoides*, as assessed under general anaesthesia.

The eastern bluetongue skink inhabits a wide variety of environments from coastal heath and forests to woodlands and grassy plains. They are omnivorous animals and feed on insects, carrion, snails and native fruits and flowers. Breeding occurs from September to November and females give birth to five to 24 live young from December to February (Cogger, 1975, Ehman, 1992).

CASE REPORT

A free-ranging, adult (242 g) female eastern bluetongue skink, *Tiliqua scincoides scincoides,* of unknown age was presented to the Australian Wildlife Health Centre in October 2006 after suspected road trauma. On initial clinical examination the animal was depressed and palpation revealed an open displaced transverse fracture of the right mandible and unstable hard palate. The lethargy and depression observed was thought to be secondary to hypovolemic shock secondary to blood loss although no supportive blood work was obtained. At this time the skink was considered a poor candidate for general anesthesia and repair of the fractures so treatment was initiated with 21 ml/kg lactated Ringer's solution (Baxter Healthcare Pty Ltd, Toongabbie, NSW), IV in the ventral coccygeal vein. Butorphanol 1.5 mg/kg (Dolorex™, 10 mg/ml, Intervet Australia Pty Ltd, Bendigo East, Vic), and carprofen 4 mg/kg (Rimadyl, 50 mg/ml, Pfizer Pty Ltd, West Ryde, NSW), were given intramuscularly (IM) for pain management. The skink was then placed into an Intensive Care Unit at 32°C (89.6°F) for observation. Reassessment the next morning revealed the skink to be bright and alert and it was decided to anesthetise the animal in order to evaluate the extent of the injuries.

Anesthesia was induced with 9 mg/kg propofol (aquaFol, 10 mg/ml, Parnell Laboratories (Aust) Pty Ltd, Alexandria, NSW), IV given into the ventral coccygeal vein. Anesthesia was maintained using 1.5% isoflurane (Isorrane 100% Isoflurane USP, Baxter Healthcare Pty Ltd, Old Toongabbie, NSW) in oxygen delivered via an 18 ga IV catheter sleeve acting as an endotracheal tube. Intermittent positive pressure ventilation was performed every 20 – 30 sec for the duration of the procedure. Examination under general anesthesia confirmed the open mandibular fracture (Figure 1) and hard

Figure 2. Appearance after reduction of mandibular fracture with intramedullary pin.

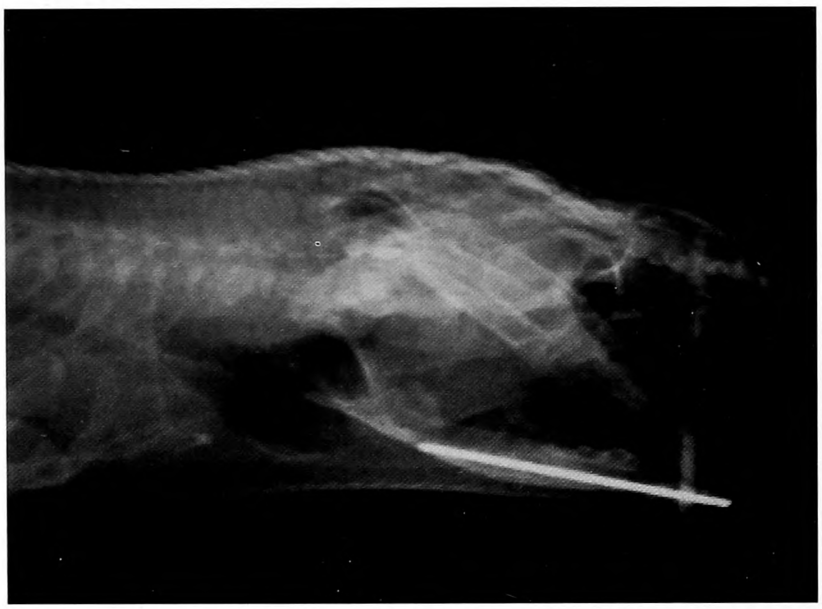

Figure 3. Post-operative radiograph of mandibular fracture repair. The straight line traversing the image is a gag to hold the mouth open.

palate instability as well as displacement of the mandibular symphysis and a slab fracture of the caudal third of the dental arcade of the left maxilla. Radiology further revealed a closed non-displaced transverse fracture of the mid left mandible. Despite the multiple orthopedic injuries that this animal had suffered it was felt that stabilization of the mandibular and maxillary fractures would yield a return to function such that the animal would be able to be released. The skink was prepped for surgery and given an additional 21 ml/kg lactated Ringer's solution, IV in the ventral coccygeal vein.

The displaced mandibular fracture was open and thus no surgical approach was required. It was reduced with a 1.0 mm intramedullary pin (Kruuse Marslev, Denmark, imported DSL Australia) inserted in a retrograde fashion. The pin was inserted into the rostral (distal) fragment inside the mouth exiting from the rostral mandible and then normograded through the medullary cavity into the caudal (proximal) portion of the mandible such that the pin did not penetrate the angle of the jaw. Fracture reduction with good apposition of the fracture segments was achieved using this technique (Figure 2 and 3) although a considerable amount of force was required to place the pin correctly.

The symphysis was stabilised using 5-0 polyamide monofilament (Dafilon®, B. Braun Australia Pty Ltd, Bella Vista, NSW). A 22 ga needle was inserted through the skin on the ventral aspect of the symphysis and then passed along the lateral mandibular surface, exiting in the oral cavity. The suture material was threaded through the needle and the needle was then repositioned on the opposite side of the mandible. The suture was then curved over the mandible between the teeth and reinserted through the needle. The ends of the suture material were tied together with a surgeon's knot, on the ventral aspect of the mandible, using a hemostat to clamp the knot so that maximum tension could be achieved (Figure 4).

The hard palate was repaired by suturing the mucosa across the fracture line with 5-0 polyamide monofilament (Dafilon®, B. Braun Australia Pty Ltd, Bella Vista, NSW). Although the fracture was reduced using this technique it was not stable. Given the size of the patient and the delicate nature of the skull no further attempts were made to increase the stability of this fracture.

Similarly, the left maxillary slab fracture was reduced using 5-0 polyamide monofilament (Dafilon®, B. Braun Australia Pty Ltd, Bella Vista, NSW), in a horizontal mattress pattern, that passed from the mucosa of the hard palate, over the caudal surface of the fragment and then through the buccal surface of the lip back over the cranial surface of the fracture to the mucosa of the hard palate and secured with a surgeon's knot.

The bluetongue skink recovered uneventfully from anesthesia and pain was managed with butorphanol 1.5 mg/kg (Dolorex™, 10 mg/ml, Intervet Australia Pty Ltd, Bendigo East, Vic), and carprofen 4 mg/kg (Rimadyl, 50 mg/ml, Pfizer Pty Ltd, West Ryde, NSW), IM q 24 hr for five treatments. Prophylactic antibiotic treatment was initiated with ceftazidime 20 mg/kg (Fortum™, 90 mg/ml, GlaxoSmithKline Australia Pt Ltd, Boronia, Vic), IM q 72 hr for five treatments.

Post-surgical care and housing consisted of a plastic tub one and a half meters long, half a meter high and half a meter wide. Newspaper was used as substrate and a wooden log acted as a hide. Access to ultraviolet radiation was provided in the form of a 36 inch Reptistar fluorescent tube (Sylvania Lighting Australasia, Lisarow, NSW) and to allow the animal to thermoregulate, a temperature gradient of 20 – 35°C (68 – 95°F) was achieved using a 150 W ceramic infrared heater (Oz Black, Ultimate Reptile Suppliers Pty Ltd, Dry Creek, SA) hung over the tub.

Initially the animal was reluctant to eat and was stomach tubed with 10 ml Hill's a/d diet (Hill's Pet Nutrition Inc, Topeka KS) once every three days for three weeks. After this time she began to accept snails with their shells removed and

Figure 4. Ventral view of surgical site. Black arrow indicates suture used to secure mandibular symphysis, white arrow indicates site of pin exit.

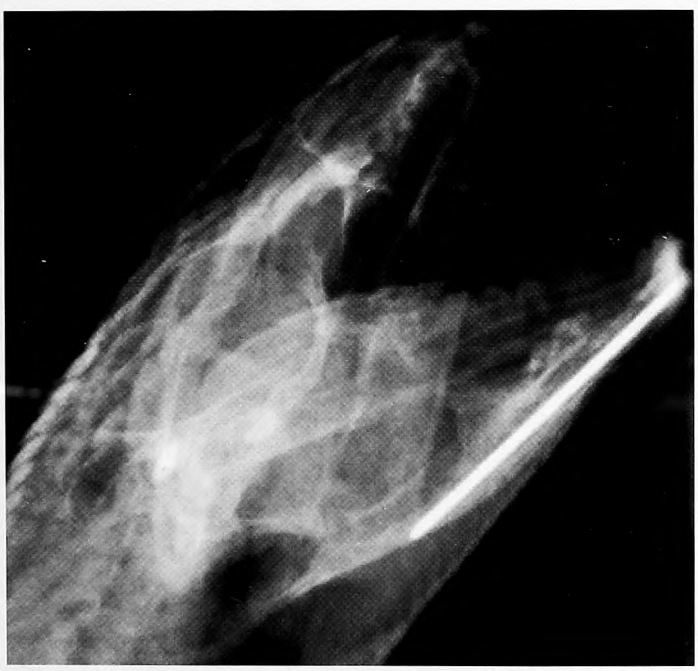

Figure 5. Pre-pin removal radiograph showing good callous formation and boney growth at fracture site.

soft fruits and by four weeks post-surgery was eating very well. At this time, a variety of food items were offered three times a week and included the following: crickets, snails, galleria grubs, finely chopped lettuce, apple, banana, orange, grape, broccoli, melon, minced meat, dandelion, watercress, currants, puppy chow and fly pupae. Insects were dusted with a calcium and multivitamin supplement (Reptile One, Vetafarm Australia, Ingleburn, NSW) twice a week.

Radiographs taken approximately two months post-surgery, showed no evidence of bone healing despite a good appetite and a decision was made to increase exposure to natural ultraviolet radiation (UV). Weather permitting the skink was placed outdoors in direct sunlight for one to two hours a day. At three months post presentation, the skink surprisingly gave birth to thirteen live babies which were subsequently released. The animal was not assessed as being gravid at presentation. Ultraviolet exposure continued, the animal maintained a good appetite and gained 30 g in three weeks. Repeat radiographs taken approximately 3.5 m post surgery (two months after exposure to natural UV began), (Figure 5) revealed complete healing of all fracture sites with excellent bony callous formation. The pin was subsequently removed from the mandible and the animal released one week later at the original point of capture.

Discussion

Orthopedic problems in reptiles can occur either as a result of nutritional deficiencies or trauma and are common reasons for reptiles to be presented to veterinarians (Mitchell, 2002, Mader, *et al*, 2006). Regardless of the cause the basic principles for fracture fixation that apply to mammalian or avian species are also important in reptilian patients. In order to encourage healing, fractures require rigid stabilization and anatomical alignment with minimal disturbance to soft tissue, especially blood supply (Fossum, 1997b, Mader, *et al*, 2006).

A range of techniques and surgical implants have been used to repair fractures in reptiles including intramedullary pins (Hartman, 1976, Redisch, 1978a, Redisch RI, 1978b, Mitchell, 2002, Mader, *et al*, 2006), bone plates (Robinson, *et al*, 1978, Crane, *et al*, 1980, Mitchell, 2002, Mader, *et al*, 2006), external fixation (Mitchell, 2002, Mader, *et al*, 2006) and combined therapies with bone cement, bone grafts and direct electrical stimulation (Mader, *et al*, 1986, Mitchell, 2002, Mader, *et al*, 2006). To the authors knowledge this is the first reported case of repair of a mandibular fracture in an eastern bluetongue skink with an intramedullary pin.

Just as in small animal medicine, reptilian patients that are presented with suspected orthopedic injuries need to be assessed prior to surgical intervention to evaluate the most appropriate technique that will facilitate dynamic repair with an adequate return to function. This is especially pertinent in free-ranging individuals as many injuries that may be manageable in captive situations may inhibit an animal's ability to survive in the wild. Factors to consider include age (in captive animals), health and nutritional status, whether it is cancellous or cortical bone that is involved, anatomical location of injury, high or low velocity injuries, open or closed fractures (reptilian fractures are rarely compound due to the elastic nature of their skin (Mader, *et al*, 2006)) and in captive animals client or keeper compliance (Fossum, 1997b, Brinker, *et al*, 1990). Additional factors to consider in reptiles include their smaller size, slower metabolic rate that may result in increased pin migration (Mader, *et al*, 2006) and comparatively narrower medullary cavities. Once these features have been contemplated the fracture can be graded as high or low risk for surgical repair. This process is termed "fracture-assessment scoring" (Fossum, 1997b, Brinker, *et al*, 1990) and may guide the clinician as to the best approach (surgical or non-surgical) and choice of implant system.

Maxillary and mandibular fractures in small animals usually occur as a result of head trauma (Fossum, 1997c) and the methodology of repair depends on the preference of the surgeon. Fossum, 1997c, does not advocate the use of intramedullary pins due to the high concentration of nerves and the vascular nature of the mandibular canal. Conversely, Brinker, *et al*, 1990, does not have the same reservations but warns that the mandible is dense and intramedullary pins can be difficult to pass. No indication of morbidity was noted in this case with the use of an intramedullary pin as evidenced by the animal's ability to prehend and masticate food once the swelling from the surgery had subsided. Furthermore, complete healing of the fracture site was considered to have occurred at three and a half months post-surgery as assessed by radiology.

Another factor to be aware of when managing mandibular fractures in small animals is the presence of tooth roots that may have been injured during the initial assault, or alternatively during stabilization (Fossum, 1997c). However, bluetongue skinks are members of the family Scincidae and as such they possess pleurodont dentition (McCracken, 1999). This means that teeth will not be disrupted with the passage of intramedullary pins into the medullary cavity of the mandible as they are attached to the lingual aspect of the jaws (McCracken, 1999). It was observed during this procedure that a considerable amount of effort was required to correctly position the intramedullary pin into the mandible. This may have been because the medullary cavity was very narrow and the bone at the rostral aspect of the distal fragment was very dense.

While bone healing is well described in mammals (Brinker, *et al*, 1990, Fossum, 1997b) and birds (Newton, *et al*, 1977, Wander, *et al*, 2000) a paucity of information exists about this process in reptiles (Mader, *et al*, 2006). Irwin, *et al*, 1986, showed that fracture repair of reptilian dermal bones (including the mandible) failed to produce secondary chondrogenesis. The implications of no chondrogensis though remains unclear. Nevertheless what is known is that healing times for fractures are vastly increased when compared to endothermic animals and this may be as a result of their slower metabolic rate. Although Mader, *et al*, 2006, advises that traumatic fractures in reptiles generally take about 6 to 18 m to heal while those that occur as a result of metabolic derangements heal within six to eight weeks providing the underlying cause is corrected, good fixation of fractures may facilitate removal of implants as early as 14 wk post-surgery (Hartman, 1976). In this case complete resolution of all the fractures had occurred three and a half months after surgery. It is also plausible that without the increased metabolic demands of follicular development and fetal maturation that healing time may have been greatly shortened. No alterations to the captive management of this animal were made in order to meet this increase in reproductive activity as the animal was not assessed as being gravid at presentation. The role that vitamin D plays in the calcium homeostasis of herpetofauna has been well illustrated (Mader, 2006) and this case is a good reminder that access to unfiltered natural UV radiation may play an important function when managing bony injuries in reptiles.

Of critical importance when managing surgical or traumatic wounds in any species is the provision of adequate analgesia. Animals that are treated for peri-operative pain return to function (e.g. eating, drinking) sooner than those who are left untreated (Fossum, 1997a). It is widely accepted that reptiles posses the neuro-anatomical pathways to detect pain and respond to noxious stimuli (Bennett, 1998a, Bennett, 1998b, Bradley, 2001, Greenacre, *et al*, 2006) but, paradoxically, little is known about managing pain in these species. Greenacre, *et al*, 2006 determined that butorphanol at a dose of 1.5 mg/kg delivered via intramuscular injection provided analgesia in the green iguana and that is the rationale behind why this dose was chosen in this case. No information exists for the pharmacokinetics of analgesic medication in Australian skinks. More recent research however has shown that butorphanol does not provide adequate antinociception in red-eared slider turtles, *Trachemys scripta*, at doses as high as 28 mg/kg and that although morphine caused longer-lasting respiratory depression than butorphanol, adequate pain-relief was observed with doses of 1.5 mg/kg (Sladky, *et al*, 2007). This author now uses morphine at this dose for all procedures in reptiles in which pain can be expected but has not observed any significant behavioural differences to indicate increased comfort level. Little information exists regarding the use of nonsteroidal anti-inflammatory drugs in reptiles (Schumacher and Yelen, 2006) and more research is needed in this area but it is presumed that they provided some degree of analgesia and aid in the reduction of post-operative inflammation.

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