ISSN 1759-0116 (Online)

ZooNova

Occasional Papers in Zoology

Number 22, Pages 1 – 16

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Published on-line at https://zoonova.afriherp.org

Afriherp Communications, Greenford, United Kingdom

Date of publication: 4 February 2023

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Surgical Removal Of Fish Hooks From Marsh Terrapins, *Pelomedusa galeata* (Chelonia: Pelomedusidae) In Kwazulu-Natal, South Africa: Three Cases Exemplifying Technical Considerations

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ABSTRACT

Terrapins are not infrequently caught by anglers in southern Africa. Although oesophageal lacerations caused by fish hooks are surgical emergencies that require prompt repair with meticulous technique, few cases appear to have been reported. Three cases of differing degrees of severity are presented to illustrate approaches to surgical management.

KEY WORDS

Chelonia; *Pelomedusa galeata*; anglers; oesophageal trauma; emergency surgery.

INTRODUCTION

Fishermen in southern Africa not infrequently catch terrapins while angling in dams or pans with gently sloping shores and still waters. Indeed, the type specimen of the Mashona Hinged Terrapin, *Pelusios rhodesianus*, was collected this way. Information on such occurrences is largely anecdotal, and I have not had many cases in nearly six decades of reptile surgery. However, unpublished personal observations suggest that unintended catches may be more common than generally appreciated, particularly in pans large enough to support good populations of such popular angling fish as the Largemouth Bass, *Micropterus salmoides*, in which terrapins also usually occur in large numbers (Figs. 1 and 2).

Three cases, spanning the sixteen years from 2007-2013, are presented here to illustrate the nature and extent of injuries encountered, and approaches to surgical management. The few cases that I have seen from as far back as 1970 were, generally, moderately large to large terrapins (usually about 25-30 cm shell length); all had taken large, plain, baited hooks rather than lures; and all had been caught in pans or dams. All were Marsh Terrapins, *Pelomedusa galeata* (Schoepff, 1792) [previously called *Pelomedusa subrufa* (Bonnaterre, 1789)]. Surgical anatomy is outlined in the Discussion (Fig. 16).

Except where specifically indicated to the contrary, all interpretations in this paper are based on my own observations and conclusions which are recorded either in my field note books going back to 1962, or in my clinical records and patient charts, which go back to 1965.

ACCOUNT OF CASES

Case 1: Hook embedded in lower jaw, with insignificant trauma

History

An adult male, carapace length 250 mm, mass 2.185 kg, referred by the Pietermaritzburg branch of the Society for the Prevention of Cruelty to Animals in February 2007, with a length of fishing line protruding from his mouth and a hook believed to be still embedded somewhere.

On full physical examination the patient was conscious, alert, and responsive. He was well nourished, with no external evidence of old or recent injuries. The mouth could not be opened for examination without risk of exacerbating any probable injury while the patient was awake. A hook could not be palpated.

Fig. 1. A large pan, typical *Pelomedusa* habitat. Note the gently sloping shore and the absence of tall marginal vegetation, favoured by anglers and terrapins alike. The middle of the pan is more than two metres deep.

Fig. 2. Part of the shoreline of the pan in Fig. 1, showing a typical terrapin basking site. The population density here is high, and many anglers regard this as an indication of good fishing.

Surgery

Amoxicillin, 30 mg intramuscularly, was given half an hour before operation.

On the basis of an empirically derived protocol of 80-100 mg/kg body mass for *Pelomedusa*, the patient was anaesthetised with Ketamine 100 mg and Acepromazine 2 mg intramuscularly (i/m), induction being moderately slow (half an hour). Breathing was

spontaneous, and no airway maintenance was required. The procedure was performed with the patient in ventral recumbency, the mouth held open with a small speculum.
The hook, which was slightly corroded, was embedded in the left ramus of the mandible, beneath the tongue, with insignificant soft-tissue injury. It was grasped with artery forceps and extracted without difficulty, and without causing further trauma. The small puncture wound was irrigated with sterile saline, but no further intervention was attempted.

Post-operative management

Recovery from the anaesthetic was slow but uneventful. There were no post-operative complications.
Two further doses of Amoxicillin 30 mg i/m were given at 24-hour intervals following the initial dose, after which the terrapin was returned to the wild.

Case 2: Hook embedded in oesophagus, with minimal trauma

History

A juvenile female, carapace length 150 mm, mass 407 g, was caught unintentionally by an angler in December 2013, and brought to my clinic within two hours. No attempt had been made to remove the hook, the line having been cut immediately after the terrapin had been taken from the water.
On examination, the patient was alert, conscious and responsive, and in good general condition. There was no external evidence of any injuries, either old or recent, but a mass consistent with the size and shape of a hook about 20 mm long could be palpated at the base of the throat (Fig. 3). Pre-operative endoscopy under general anaesthesia, immediately before starting surgery, revealed that the point and barb of the hook appeared to be embedded in the wall of the oesophagus without lacerating it.

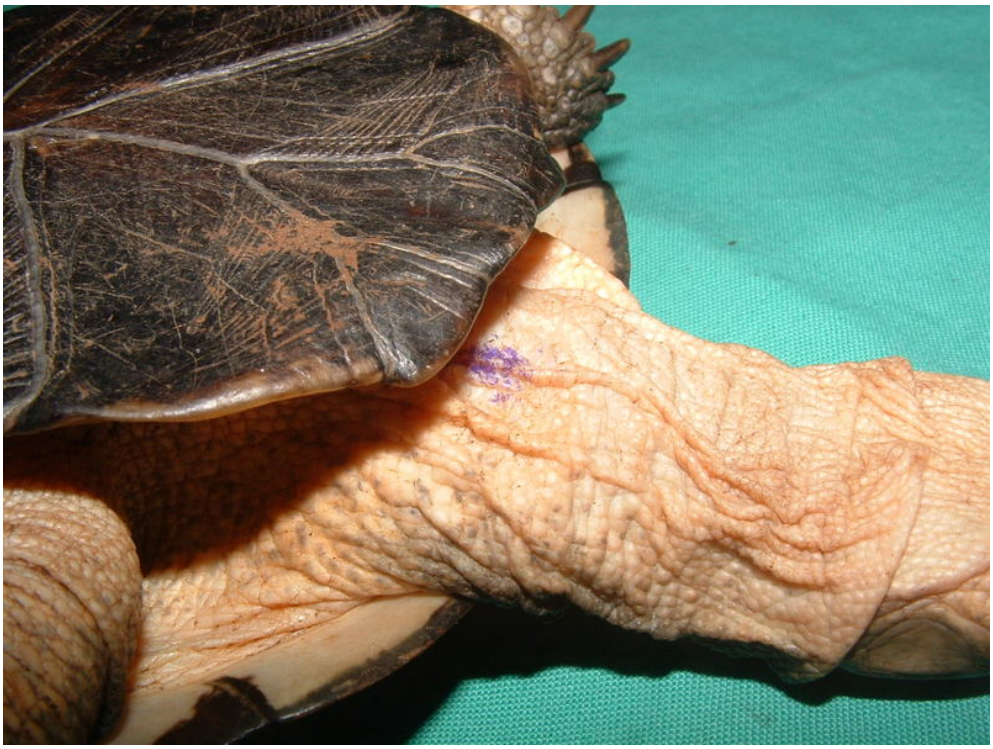

Fig. 3. The position of the hook is indicated by the purple skin-marker line. This is the point at which most hooks in the cases that I have seen are usually lodged.}

Surgery

Amoxicillin 15 mg was given i/m half an hour before surgery. Surgical plane anaesthesia was induced with Ketamine 40 mg i/m. Breathing was spontaneous throughout, with no airway maintenance required. The patient was kept in dorsal recumbency.

The oesophagus was exposed by a midline incision through the skin and underlying tissues. A short incision through the oesophageal wall, between two stay sutures, was made directly over the point of the hook, which was grasped with fine forceps and brought through it (Fig. 4). The curved portion of the hook, with its barb, was divided with wire-cutting forceps and the shank was gently pulled out through the mouth by the still-attached length of line (Fig. 5). The oesophageal incision was carefully debrided and closed with 6-0 interrupted sutures, maintaining precise apposition of the margins (Fig. 6). The throat tissues were closed in layers, also with interrupted 6-0 Vicryl (Fig. 7), and the skin with 5-0 Vicryl (Fig. 8).

Post-operative management

The hook caused insignificant damage to the oesophagus and surgical repair, other than closing the stab incision, was not indicated. Two further prophylactic doses of Amoxicillin 15 mg i/m were given 24 hours apart after surgery. Recovery was uneventful, and the patient was released three days after operation.

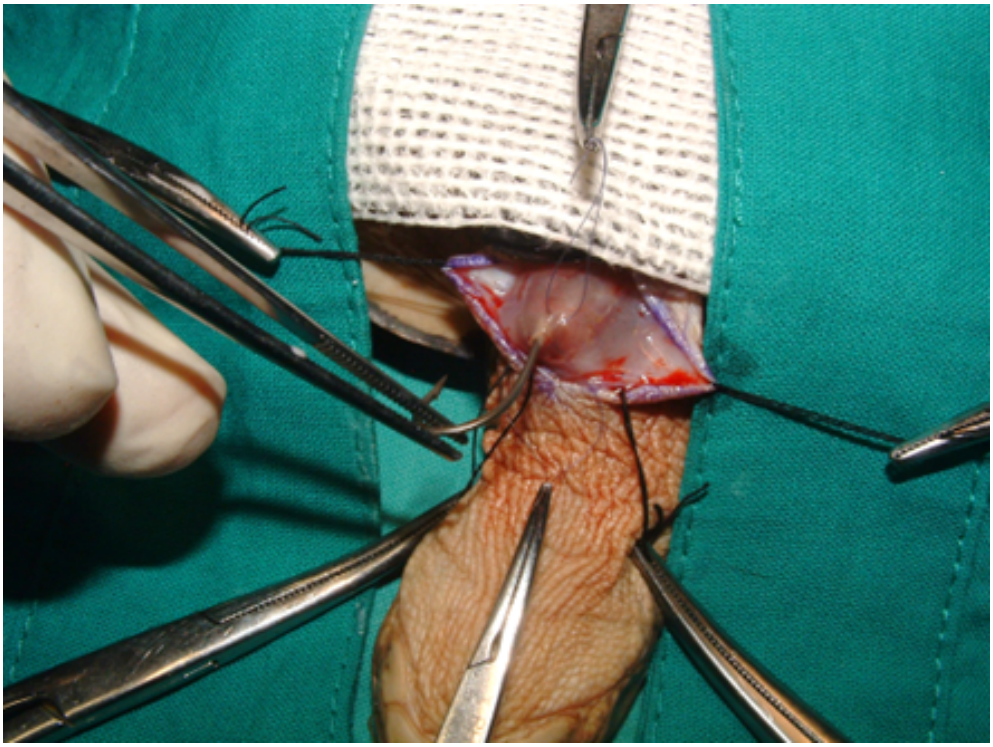

Fig. 4. The point of the hook has been delivered through a small stab incision.

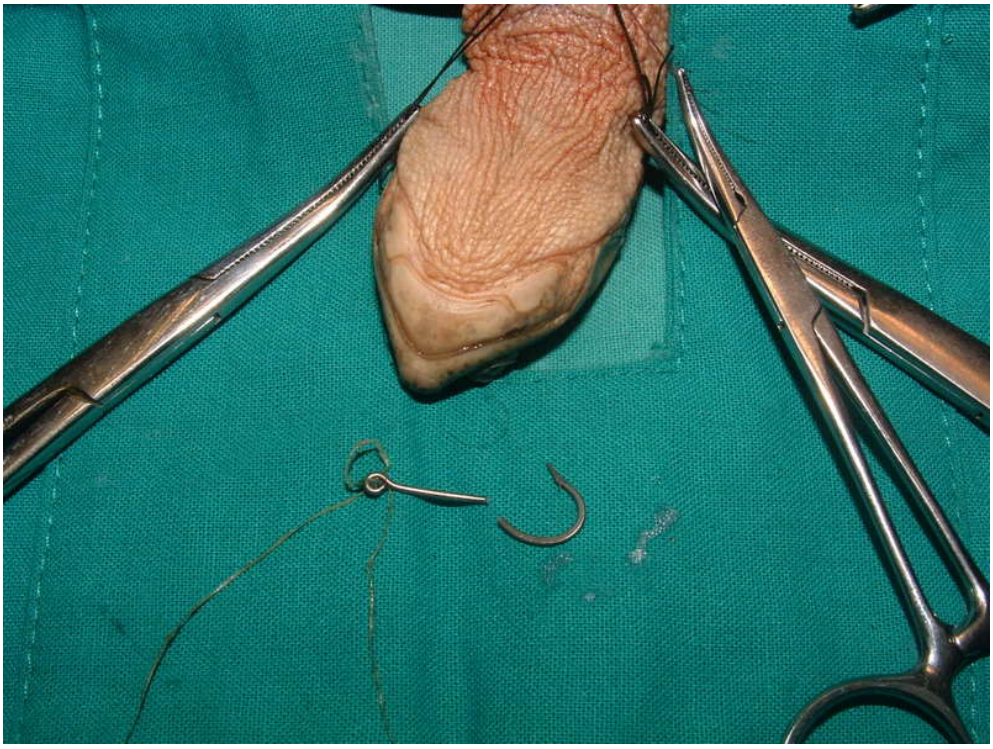

Fig. 5. Cutting through the shank of the hook allowed it to be withdrawn through the mouth easily and safely.

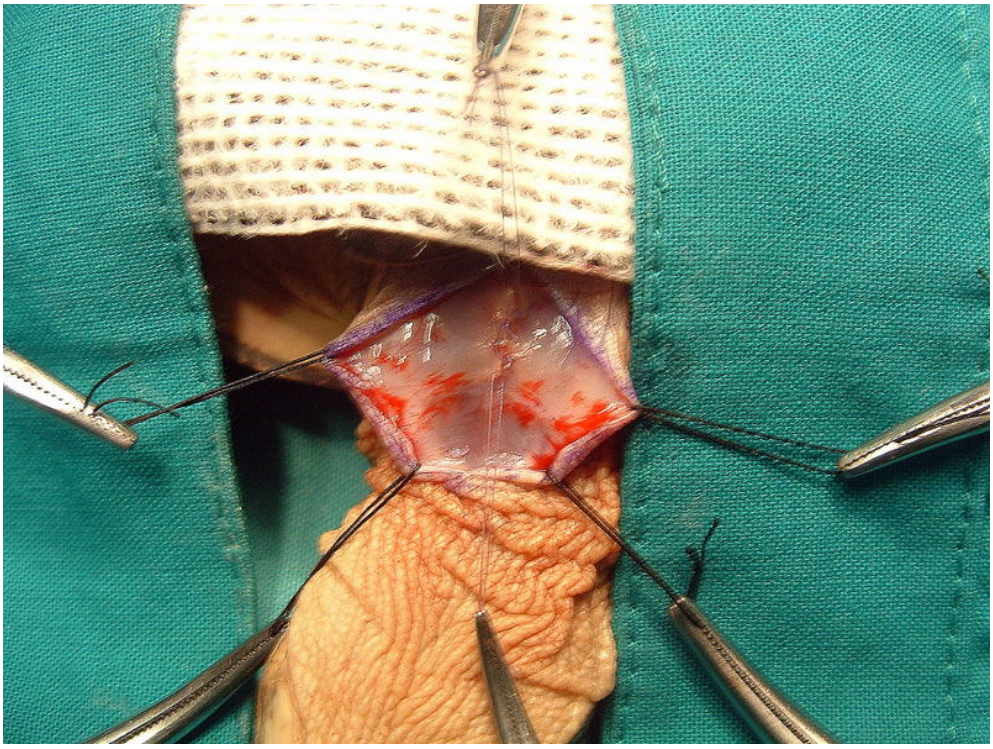

Fig. 6. The oesophagus is closed with interrupted Vicryl sutures.

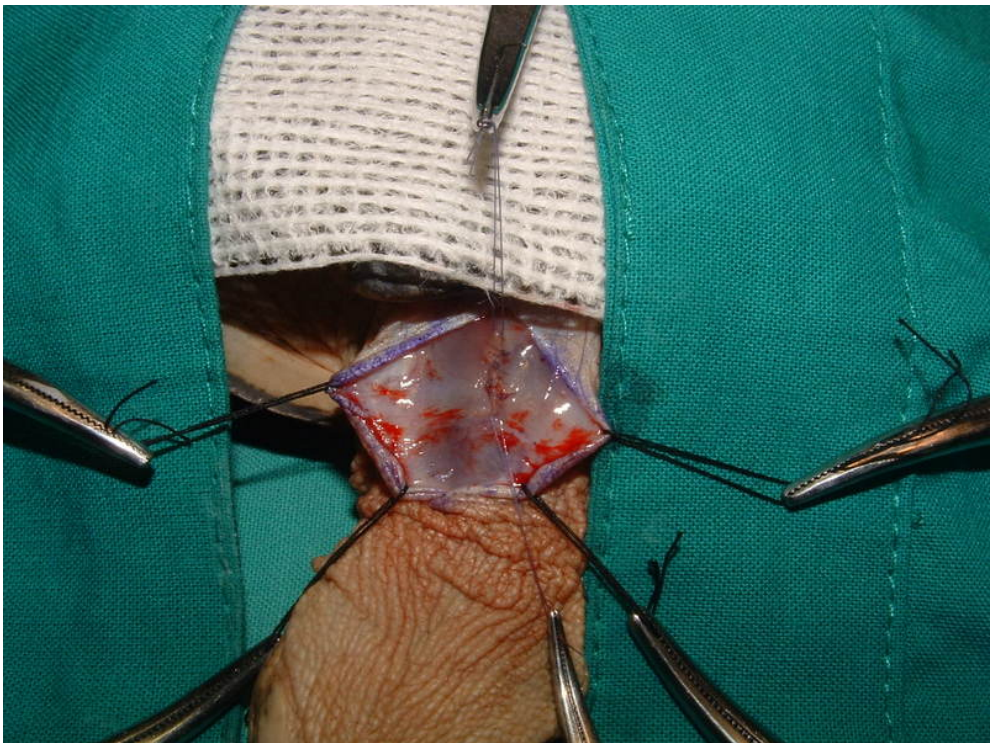

Fig. 7. The throat tissues are closed in layers with 6-0 Vicryl sutures.

Fig. 8. The skin is closed with 5-0 interrupted Vicryl sutures.

Case 3: Hook embedded in oesophagus, with major trauma

History

An adult male (carapace length 250 mm, mass 2.320 kg), referred by FreeMe Wildlife, a wildlife rescue and rehabilitation centre, in January 2010. He had been caught by an angler

late in the previous afternoon, and referred for surgery by Dr. Margie Roach immediately after being X-rayed.
On examination he was conscious, alert, responsive and very active. He was well nourished and in excellent general condition, and a full physical examination showed no detectable abnormalities other than a palpable mass in the throat and a length of fishing line protruding from the mouth. The X-ray revealed a hook 45 mm long, 23 mm across the curve, in the oesophagus. The top of the shank was 110 mm from the tip of the mandible, the curve of the hook 150 mm from the tip (Fig. 9). No radiological abnormalities, other than those associated with the hook and adjacent tissues, were seen.

Fig. 9. Position of the hook revealed by X-ray.
The hook is embedded lower down than usual, bespeaking more difficult surgery.

Surgery
A prophylactic dose of Amoxicillin 35 mg, and 0.5 mg Acepromazine (following an empirically derived protocol, for light sedation in *Pelomedusa*, of 0.25 mg/kg) as a pre-anaesthetic sedative, were given i/m half an hour before anaesthetising with Ketamine 180 mg i/m. A combination of Acepromazine and Ketamine is usually very effective with terrapins but, in this instance, induction was very slow (three hours) and only a very light plane of anaesthesia was achieved before the patient began to awaken. Because it was now late in the evening and the patient needed time to recover fully from the anaesthetics before another attempt, surgery was postponed until the next morning despite the very real dangers associated with further delay.
Surgical plane anaesthesia on this second attempt was achieved slowly (one hour) but satisfactorily with Ketamine 100 mg and Medetomidine 25 µg, i/m. The patient was placed in dorsal recumbency, with slight anterior elevation, and the neck fully extended. The procedure took two and a half hours, and a second dose of Ketamine 100 mg and Medetomidine 25 µg was needed halfway through. No airway maintenance was required, and respirations were spontaneous throughout.

The oesophagus and adjacent muscles and blood vessels were found on pre-operative endoscopy to be badly lacerated, and extensive repairs were indicated. Simple removal of the hook in the way described in Case 2, above, was not possible (Fig. 10). Because the oesophagus was so widely torn, it was relatively simple to free the hook and remove it without further incision (Fig.11).

The wound was carefully explored and the lacerated, irregular margins of the oesophageal defect (involving mucosa, submucosa, muscularis, and serosa) were excised as completely but as conservatively as possible, using curved iris scissors and a fine Adson forceps, keeping the resulting linear defect as small as possible to reduce tension on the suture line. Lacerations to adjacent loose connective tissue and throat muscles required minimal excision of soiled margins. The wound was irrigated with isotonic saline before beginning repairs.

The oesophagus was sutured in layers with 6-0 and 4-0 Vicryl continuous sutures, with slight inversion of the mucosa, and muscles were sutured with 6-0 PDS II in an interrupted pattern (Figs. 12 and 13). Blood vessels were repaired with 10-0 Vicryl where possible, or ligated with 6-0 Vicryl. The skin was closed with interrupted 4-0 CliniSorb Polydioxanone sutures inserted with a slight everting action.

The skin was closed with 4-0 Polydioxanone interrupted stitches using a slightly everting pattern (Fig. 14).

A feeding tube was passed into the stomach via a left lateral oesophagostomy, following standard techniques (Fig. 15).

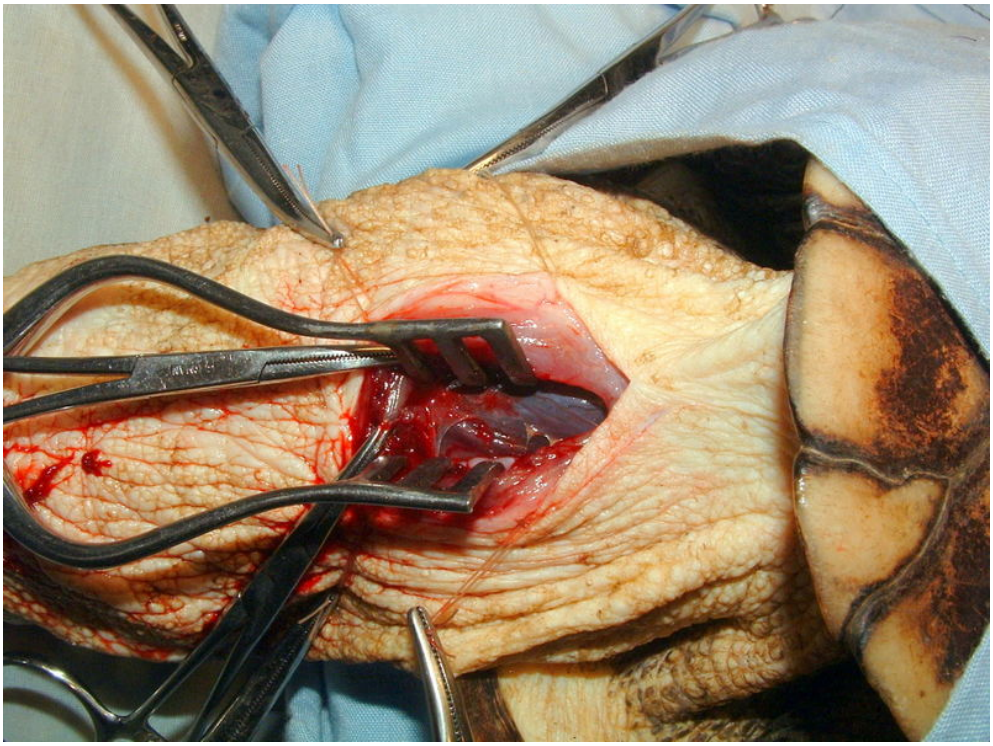

Fig. 10. The extent of lacerations caused by strong traction on the hook is revealed.

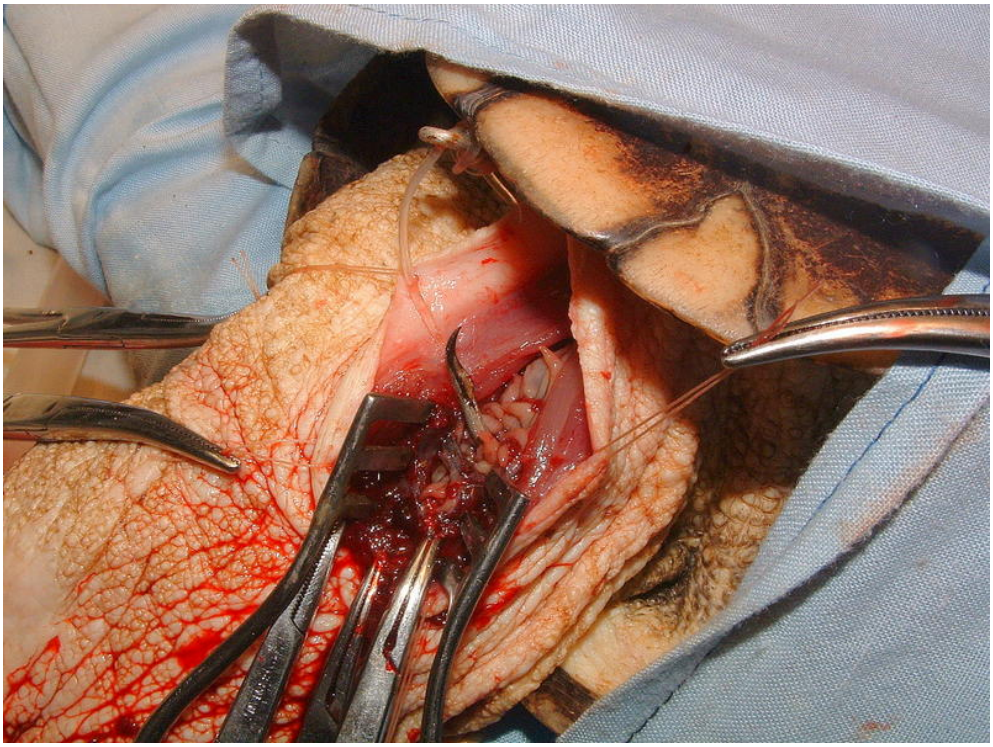

Fig. 11. The point of the hook was lying free in the torn oesophagus, allowing easy retrieval.

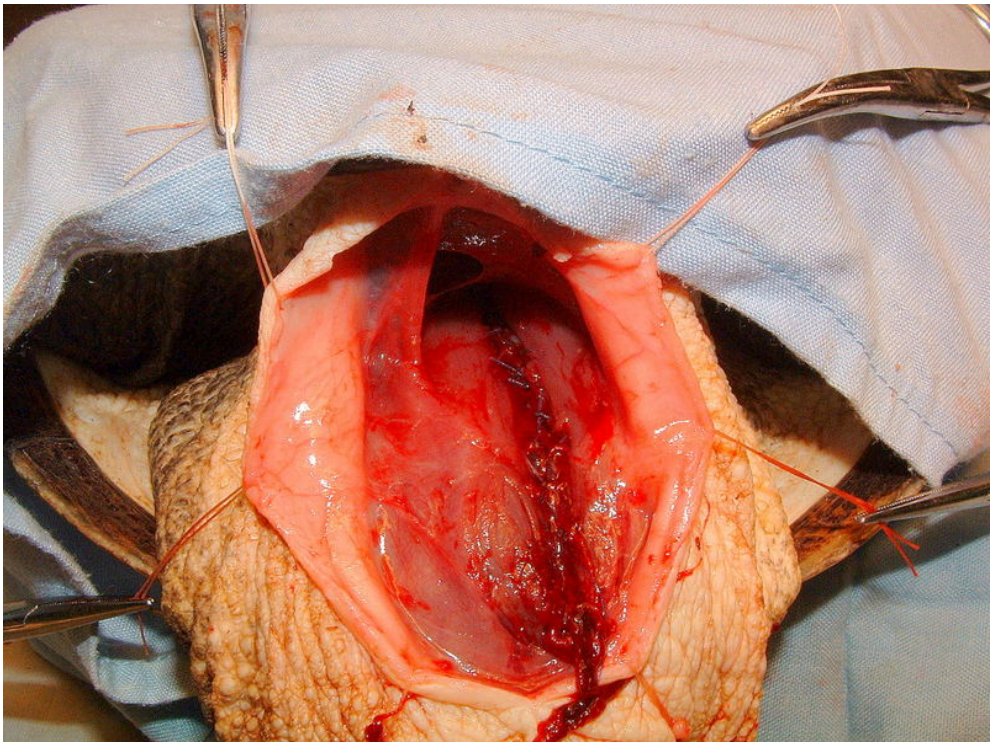

Fig. 12. Wound excision has been completed, and the oesophageal laceration closed in accurately apposed layers.

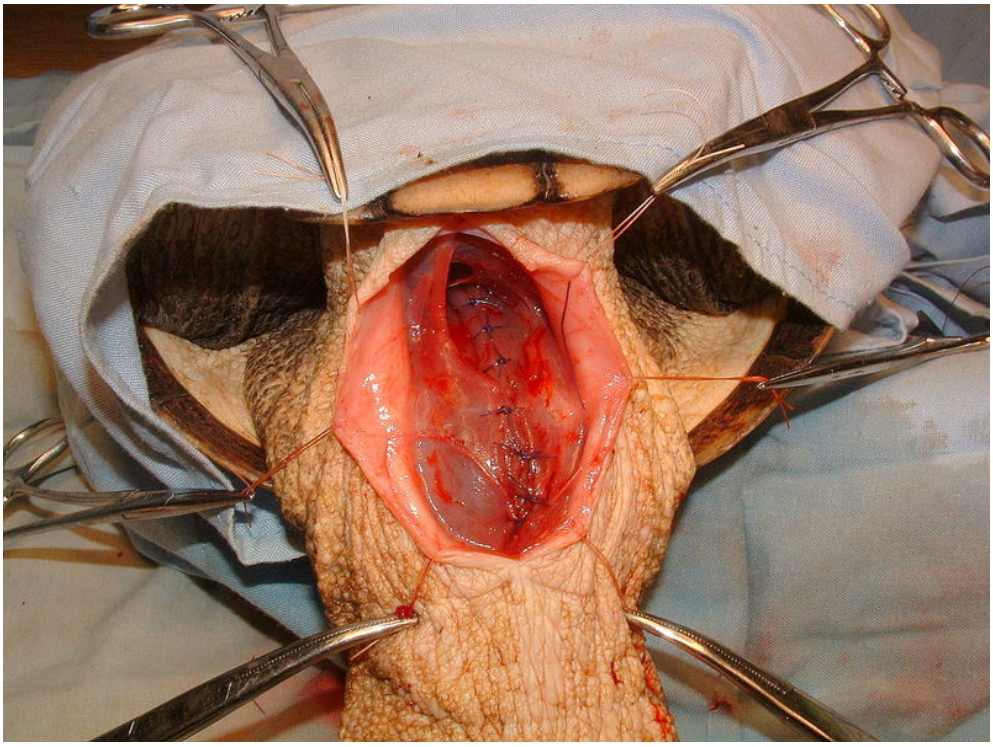

Fig. 13. Vascular repairs completed. Deep throat muscles have been tacked around the oesophageal repair for reinforcement, and the remaining tissues are being closed in layers.

Fig. 14. Skin closure, using simple interrupted sutures.

Fig. 15. Oesophagostomy tube held in place with a purse-string suture and adhesive tape.

Post-operative management

Antibiotic cover was continued postoperatively for four days, Amoxicillin 35 mg i/m, and Metronidazole 50 mg by tube, every 24 hours.

Pentazocine 3 mg i/m was given every six hours for pain relief.

Paediatric Maintenance Fluid with 5% Glucose (PMS+5G), 15 ml by tube, was given every six hours for the first two days, then 7.5 ml of PMS+5G with 7.5 ml of beaten egg by tube 12 hourly subsequently for three days.

Recovery was slow for the first two days, but much more rapid subsequently and he was soon fully conscious, alert, behaving normally, and much stronger. There was no evidence of post-operative bleeding, determined by intermittent aspiration of the feeding tube for the first three days, and the suture line was healing very satisfactorily.

On the sixth day after surgery, the terrapin was found dead less than an hour after his last routine two-hourly check. No clear cause of death was established on post-mortem examination: all repairs had been healing very well, there was no infection, no bleeding, and no electrolyte disturbances.

DISCUSSION

Evaluation of cases presenting with perforation of the oesophagus

Perforation of the oesophagus is a potentially fatal condition (Chen & Duranceau, 1998). Conservative management is justifiable only in an old lesion that shows no evidence of sepsis, or if there is a small fistula opening to the surface, not communicating with the coelomic cavity. It should not be considered in the case of fish hook injuries.

If the injury is less than 24 hours old, and if endoscopy shows that lacerations are not excessively extensive, primary repair including thorough debridement and suture of the defect may be indicated. Such instances are, in my experience, uncommon in wild animal surgery.

If the injury is more than 24 hours old, repair is more challenging because concomitant tissue necrosis and oedema make identification of oesophageal wall layers, essential to satisfactory

repair, much more difficult. This is usually the case in terrapins presenting with a fish hook in the oesophagus. There do not seem to be figures available for mortality rates in these instances, but it seems reasonable to assume, on the basis of personal experience, that Chen & Duranceau's remark (1995) that mortality in humans is doubled, or even tripled, beyond the 24-hour limit may be at least broadly applicable to chelonians. The prognosis for reptiles with perforating injuries of the upper oesophagus more than 24 hours old seems to be better than for those with more distal injuries, becoming more guarded the closer to the stomach the injury is. I have not found any reference to studies on the prognosis for oesophageal trauma of this kind in the literature available to me.

Anaesthesia

Reptiles generally, and especially chelonians, are notoriously difficult to anaesthetise, especially in emergency surgery which is indicated for most (about 90%) of my patients presenting for operations, and the third patient discussed here was especially problematical.

The primary objective is to achieve surgical plane anaesthesia as quickly and as safely as possible, once essential stabilising measures have been taken, and this is no simple task. Unless the patient is already unconscious or at least obtunded, prolonged breath-holding may, and all too often does, make induction with volatile agents completely impractical. Intravenous agents, too, are often impractical for a multitude of reasons including (but not restricted to) veins that are difficult to reach in chelonians that stubbornly remain withdrawn in their shell and cannot be accessed by drawing out the head or limbs without causing further injury; veins that are collapsed; or veins and sinuses that are too small.

In such cases, parenteral agents that can be administered intramuscularly seem, in my experience and within the context of a small clinic, to be the only option. There are, to be sure, problems enough even with this strategy. If the tissues are poorly perfused – which is usually the case in a shocked and often hypovolaemic patient – both the pharmacokinetics and the pharmacodynamics of the chosen agent may be significantly impaired and induction may be slower than expected, very much slower, or even completely unsuccessful. Nevertheless, in my own experience, parenteral anaesthetics are usually the agents of choice.

The principles and practice of reptile anaesthesiology, and anaesthetic agents, are well described in the literature (Frye, 1991; Mader, 2006; Perpiñán, 2018) and need not be reviewed here.

Of the many agents described in the literature I confine my present remarks to Ketamine, as used in these three specific cases, which on the basis of long personal experience I prefer for most emergency procedures. Ketamine has a wide margin of safety, and doses may be repeated if required – either to induce anaesthesia after an unsatisfactory or unsuccessful first attempt, or to prolong successful induction. It does not seem to depress respiratory activity and assisted ventilation is generally not needed, unless the presenting complaint requires it, and it does not lower blood pressure (something that may not be altogether desirable in patients with intracranial bleeds).

Depending on circumstances and clinical indications, I often use Ketamine either as the sole anaesthetic agent or in combination with Diazepam, for procedures that are expected to take no more than one hour. In complex procedures (especially with major trauma), however, when prolonged anaesthesia is anticipated, I prefer to induce light anaesthesia with Ketamine and maintain surgical plane anaesthesia with a volatile agent (previously Halothane, but now with Isoflurane). Major oesophageal trauma in chelonians would generally fall within this latter category.

Terrapins generally seem, in my experience, to need somewhat smaller doses of Ketamine, and to respond rather more rapidly, than testudinids; but exceptions do occasionally occur.

When Ketamine induction is unduly prolonged or is likely to be unsuccessful, changing to an inhalant agent may be indicated. In the case of the third patient, unfortunately, I had just run

out of Isoflurane and had not yet been able to replace it; thus, a second attempt at parenteral anaesthesia was unavoidable.

When using an inhalant anaesthetic, I generally use a Mapleson A system, less frequently a Mapleson E or D, either with a face mask of the kind described by Frye (1991) or with an uncuffed endotracheal tube. With larger reptiles requiring prolonged surgery, a re-breathing circuit without an absorption cannister (thus eliminating resistance) is more economical, even when the flow is a little greater than the minute volume to prevent excessive carbon dioxide levels.

Air is preferable to oxygen as a carrier gas for inhalant anaesthetics, as its use significantly reduces the need for assisted ventilation; there is a better response by the respiratory centres to the more normal arterial carbon dioxide and oxygen partial pressures - a major consideration when working unassisted.

Instruments

Every surgeon will have particular preferences for setting up instrument trays, and the following remarks are intended purely to indicate the basic set that I find useful for lizard, snake and chelonian neck surgery. Duplicates of instruments marked with an asterisk (*) are laid out when excising heavily contaminated or infected wounds.

Scalpel handles: No. 3, with 11 and 15* blades (a No. 10* blade may also be needed in some cases). Scissors: operating, flat, sharp and blunt-tipped, 14 cm; operating, flat, sharp-tipped, 12 cm*; iris, flat and curved*; suture cutting, 14 cm. Dissecting forceps: Gillies*, McIndoe*, standard toothed* and non-toothed*, Adson toothed* and non-toothed*, Elschnig. Artery forceps: Mosquito, 5; Halsted, straight, 10*; Crile, curved, 14 cm, 4*; Mayo-Hegar 12, 13, 14 cm. Ancillary: Dissector, Watson-Cheyney or McDonalds; sinus forceps, 13 and 14 cm.

The basic microsurgery tray includes - Scissors: Castroviejo corneal angled, flat and curved; Castroviejo sclerocorneal, curved left and right; Vannas capsulotomy. Forceps: Iris fixation, straight and curved; Oschner-Elschnig; Bonn suturing; Castroviejo suturing; Bishop-Harmon tissue, curved and straight; Pierse tying; Barraquer tying; Tennant tying; Castroviejo tying. Retractors: Hartmann ear hooks, sharp and blunt.

Surgical Anatomy

The principal structures encountered in oesophageal surgery are shown in Fig. 16.

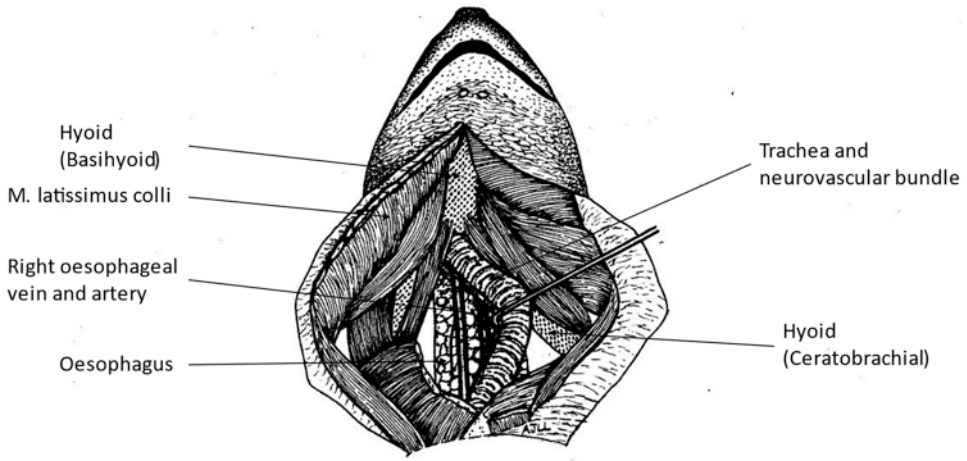

Fig. 16. Principal structures seen in oesophageal surgery. Hyoid apparatus stippled; trachea banded; oesophagus honeycombed; blood vessels and nerves black.

The fibres of the broad, transverse Latissimus colli encircling the neck immediately beneath the skin meet in the ventral midline, through which they are divided and retraced to reveal the underlying strap muscles of the throat - Omohyoid, Sternohyoid, and Sternomastoid. The body of the hyoid apparatus (stippled) lies in the midline, between the mandibles. Anterior and posterior horns diverge from the hyoid body towards the base of the neck on either side, adjacent to and partly covering the trachea (pulled to one side in Fig. 16), under which is the rather broad oesophagus. The great blood vessels and nerves of the throat lie on either side of the trachea, between it and the oesophagus, and great care is needed to identify and protect them from injury during surgery. The surgical field is perforce somewhat restricted and the body of the hyoid may have to be divided if the hook is lodged high up.

General surgical considerations

Pre-operative endoscopy greatly helps assess the extent and nature of the injuries, and the placement of the hook. An endoscopic grasping forceps may sometimes be profitably used to reposition an awkwardly-lying hook, though extraction by this means is not advisable, since the injury will almost invariably require debridement and repair.

There is little intrinsic merit in short incisions, and long midline ones not only give better exposure but permit much gentler handling of the tissues. This is especially important when microsurgical repairs are required.

A Weitlaner retractor is useful for larger terrapins, but I generally prefer stay sutures grasped with Crile artery forceps, which are both more versatile and can be kept well clear of the operating field.

If the wound is only a small puncture that is not significantly enlarged after removal of the hook, it may be left to heal without suturing, as is the case after removal of a feeding tube in elective oesophagostomy. If the perforation was enlarged when removing the hook, one or two fine interrupted all-coats, slightly inverting, sutures might be indicated.

Because the oesophagus lacks a serosa which might help seal leaks by exuding fibrin, and because it is constantly in motion during deglutition, it is more prone to dehiscence than the intestine. Longitudinal lacerations can be repaired with reasonable prospects of success, given meticulous technique, great gentleness, and minimal sacrifice of tissue, for the oesophagus tolerates distension quite well during healing. Injuries requiring resection of anything other than a really short segment usually end in failure, for the oesophagus is remarkably intolerant of longitudinal stretching and tension.

Very accurate apposition of the layers, united by small, rather closely spaced stitches, is essential. Evaluation of many patients upon whom surgery on all parts of the alimentary canal was performed over more than five decades indicates that it does not seem to make much difference whether absorbable or non-absorbable material is used, and I generally use Vicryl or Polydioxanone, for they allow smaller knots than nylon.

It is advisable to reinforce the repair by tacking adjacent throat muscles to the oesophagus. The Sternomastoid is useful for ventrally placed suture lines, and Longus colli for more dorsally placed ones, but other muscles and tissues may also be used with advantage in carefully selected instances.

Vascular surgery

Conventional techniques are sufficient for repairs to major blood vessels, if necessary, but their small size demands microsurgical instruments; I always lay out a set when major surgery of any kind is contemplated.

Because Acland clamps can only be used with difficulty, if at all, in many reptile patients, I had devised a method of occluding blood vessels using lengths of ligature with a quick-release slip knot. The same technique was independently described, some fifteen years later, by Jui, Ying, & Shen (2019), whose paper should be consulted for their excellent description of the method and a clinical evaluation of its merits.

Muscle closure

The M. latissimus colli, which lies immediately below the skin, is incised through the midline raphe in order to approach the oesophagus below the level of the hyoid body. Since the fibres are perpendicular to the incision, simple interrupted sutures, and even horizontal mattress sutures, have a tendency to pull out. Figure-8 horizontal mattress sutures hold well.

Skin closure

Despite theoretical objections to using braided absorbable sutures for skin closure, chiefly regarding the danger of infection by wicking, I have found them just as satisfactory as monofilament nylon. They have the added advantage of not having to be removed subsequently, an important consideration when dealing with wild animals. The exposed suture material soon drops off after the buried portions have been absorbed, usually within two or three weeks.

Chelonian skin varies enormously in thickness, both overall and in its constituent layers, as well as in its anatomical structure and physical or mechanical properties, from one region to another – for example that of the neck, compared with that of the lateral and medial aspects of the limbs, and of the tail – at both species and genus level. These differences may pose formidable technical difficulties in safe, effective wound closure (especially where free skin grafts may be required). The neck skin of *Pelomedusa* is fortunately straightforward to deal with, provided that it is remembered that the edges of an incision tend to roll inwards so that sutures should be inserted with a slight everting action (best achieved by gently lifting the margins slightly so that the needle is not quite perpendicular when it enters and leaves the skin; and the sutures should be placed quite closely. A simple interrupted pattern is usually sufficient, but perfection is essential if wound dehiscence is to be prevented. Subcuticular sutures are generally impractical in this region, despite their theoretical desirability.

Morbidity and mortality

Post-operative surgical morbidity in operations of the oesophagus in snake, lizard and chelonian patients has been very low, and almost always minor. Mortality rates have been even lower, only three or four altogether, and I have never been able to establish the reasons for the sudden fatal collapse of the third patient in this account.

Because of the loss, due to theft and other mischances arising from a number of relocations, of a substantial number of clinical records it is now impossible to quantify these statements reliably; but, if my memory does not betray me too severely, I have done some fifty oesophageal procedures on snakes, lizards and chelonians.

ACKNOWLEDGEMENTS

I thank Prof. Fredric Frye, Lynn Raw, and Shirley Lambiris for their most helpful comments on early drafts.

I am deeply indebted to the numerous people, many unknown to me, who over the years donated medical and surgical consumables and equipment that allowed me to operate a *pro bono* clinic for almost sixty years without ever having to turn away a patient for lack of resources.

It may be invidious to name some, but not all, of those who have helped develop my knowledge of herpetology and of reptile medicine but my indebtedness to the latter is by no means any the less. However, I must thank the late Rudyerd Boulton (ecology), the late Dr. Donald Broadley, Professor John Poynton, and the late Dr. Bill Branch (herpetology), Dr. Lawson Cairns, Dr. Deana Rautenbach, and the late Drs. Brian Corcoran and Robin Gatley, (veterinary medicine).

I also thank Dr. Bernice van Huyssteen and an anonymous referee, for their most constructive comments.

Above all, I must thank Professor Fredric Frye for his many years of support, enlightenment, encouragement and friendship; and my wife, Shirley, who has made this work possible for more than forty years through her love, support, and active involvement.

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Accepted for Publication – 2 February 2023