PREVALENCE AND MANAGEMENT OF CHELONIAN SHELL FRACTURES IN A VETERINARY TEACHING HOSPITAL IN KLANG VALLEY, MALAYSIA (2022-2024)

By

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A research paper submitted in partial fulfillment of the requirement

for the degree of Doctor of Veterinary Medicine

Faculty of Veterinary Medicine

Universiti Malaysia Kelantan

2025

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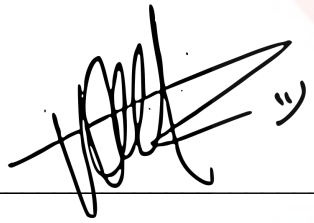

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ABSTRACT

An abstract of the research paper is presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement of the course DVT 55204 –Research Project.

Shell fracture is one of the most common traumatic injuries that affect chelonians, often requiring veterinary intervention. Despite regular presentation of chelonian cases to the University Veterinary Hospital, Universiti Putra Malaysia (UVH UPM), the prevalence and clinical management of shell fracture cases have not been previously characterised. This retrospective cohort study reviewed chelonian medical records from 2022 to 2024 (n = 123) to determine the prevalence of shell fracture cases and describe their clinical management. Four cases met the inclusion criteria, resulting in a prevalence of 3.25%. Three cases involved tortoises and one involved a terrapin, all of which were captively reared. Vehicular trauma accounted for 50% of the fractures, while one case resulted from a fall and the cause of one case was unrecorded. Diagnostic evaluation consisted primarily of physical examination and radiography, with imaging performed in 75% of cases to assess concurrent injuries. Shell fracture types include open, nondisplaced (n = 3) and closed (n = 1) fracture, while other clinical conditions associated with the fracture include dull mentation, hindlimb weakness, and evidence of systemic bleeding in one patient. Management approaches included wound cleaning, fluid therapy, analgesia and antibiotic administration, and fracture repair using epoxy glue. Two patients returned for follow-up, while outcomes for the remaining two were not documented.

In conclusion, chelonian shell fracture cases are presented at low levels in UVH UPM, and the management strategies observed are consistent with established practices for chelonian shell fracture care.

Keywords: Chelonian, Shell fracture, Epoxy glue

ABSTRAK

Abstrak kertas penyelidikan ini dibentangkan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan, sebagai memenuhi sebahagian keperluan kursus DVT 55204 – Projek Penyelidikan.

Walaupun kes chelonian kerap dibawa ke Hospital Veterinar Universiti, Universiti Putra Malaysia (UVH UPM), prevalens dan pengurusan klinikal kes retakan cengkerang belum pernah dicirikan sebelum ini. Kajian kohort retrospektif ini menilai rekod perubatan chelonian dari tahun 2022 hingga 2024 (n = 123) bagi menentukan prevalens kes retakan cengkerang serta menghuraikan pengurusan klinikalnya. Empat kes memenuhi kriteria inklusi, menghasilkan prevalens sebanyak 3.25%. Tiga kes melibatkan kura-kura darat dan satu melibatkan kura-kura air tawar, kesemuanya dipelihara secara domestik. Kemalangan melibatakan kenderaan menyumbang kepada 50% kes retakan, manakala satu kes berpunca daripada jatuh dari tempat tinggi, dan punca bagi satu lagi kes tidak direkodkan. Ujian diagnostik terdiri daripada pemeriksaan fizikal dan pengimejan radiografi, dengan pengimejan dilakukan dalam 75% kes bagi menilai kecederaan lain. Jenis retakan cengkerang termasuk retakan terbuka tanpa anjakan (n = 3) dan retakan tertutup (n = 1), manakala kondisi klinikal lain yang berkaitan termasuk kemurungan, kelemahan kaki belakang, serta tanda pendarahan sistemik pada seekor pesakit. Rawatan merangkumi pembersihan luka, rehidrasi, pemberian analgesik dan antibiotik, serta pembaikan retakan menggunakan gam epoksi. Dua pesakit telah hadir untuk rawatan susulan, manakala hasil rawatan bagi dua kes selebihnya tidak direkodkan.

Kesimpulannya, kes retakan cengkerang chelonian adalah rendah di UVH UPM, dan strategi pengurusan yang diamalkan adalah selaras dengan kaedah rawatan retakan cengkerang chelonian yang telah ditetapkan.

Kata kunci: *Chelonian*, Retakan cengkerang, Gam epoksi

CERTIFICATION

This is to certify that we have read this research paper entitled 'Prevalence And Management Of Chelonian Shell Fractures In A Veterinary Teaching Hospital In Klang Valley, Malaysia (2022-2024)' by Tasneem Binti Rafiee, and in our opinion, it is satisfactory in terms of scope, quality, and presentation as partial fulfillment of the requirements for the course DVT 55204–Research Project.

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2. Dr. Mohammed Dauda Goni
3. Dr. Luqman Bin Abdul Samad
4. Parents
5. Ahmad Amir Akmal Bin Abdul Hamid

DEDICATIONS

All praises to Allah S.W.T for the guidance, wisdom, and strength granted throughout conducting this research project, which allowed me to complete the project successfully.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

VAC - Vacuum Assisted Closure

CT - Computed Tomography

CBC - Complete Blood Count

LR - Lactated Ringer

NaCl - Sodium Chloride

AST - Antibiotic Sensitivity Test

SSD - Silver Sulfadiazene

UVH UPM - University Veterinary Hospital, Universiti Putra Malaysia

ID - Identification

MRI - Magnetic Resonance Imaging

1.0 INTRODUCTION

Chelonians refer to a group of shelled reptiles that includes turtles, terrapins, and tortoises (Bayer & Innis, 2019). These reptiles play important roles in the ecosystem, acting as seed dispersers, scavengers, and prey for other species. Their ecological importance, increasing popularity as exotic pets, and awareness of animal welfare highlight the need for veterinary attention and conservation efforts.

Among the various health problems reported in chelonians, shell fractures are recognised as one of the most common and serious traumatic injuries in both wild and captive populations (Roffey & Miles, 2018). Wild chelonians, in particular, are more frequently affected due to risks such as road traffic exposure and predator attacks (Norton et al., 2019). A shell fracture involves a disruption in the carapace, plastron, or bridge. These injuries may occur following vehicular accidents, predation, falls, or inadequate husbandry. If not properly managed, fractures can progress to soft-tissue infections, persistent pain, or even death (Norton et al., 2019).

The complexity of chelonian anatomy, combined with wide variation in fracture presentations, slow healing rates, and the need for prolonged care, makes shell fracture management a significant clinical challenge. Management of chelonians with shell fractures depends on their prognosis upon triage. Initial treatments include stabilisation with fluids, antibiotics, and analgesics, as well as wound irrigation (Fleming, 2014). The next approach widely ranges from the application of different bandage techniques to Vacuum-Assisted Closure (VAC) or external fixation with common hardware to reduce the fracture. In severe cases, euthanasia is often considered.

1.1 RESEARCH PROBLEM STATEMENT

Although shell fractures are frequently seen in veterinary practice, limited formal prevalence data have been reported in the scientific literature. In Malaysia, particularly in the Klang Valley, there is also no standardized reporting system or accessible data documenting the occurrence and management of chelonian shell fractures. As a result, the prevalence of chelonian shell fractures in Klang Valley remains unknown, and the variety of management practices used across different facilities has never been systematically recorded. Any decision on intervention for shell fractures often rely on a clinician's personal experience or case reports from other regions. However, these sources may not consider differences in local species, environmental factors, or available resources. Hence, it can be challenging to evaluate the effectiveness of current treatment methods within the local context.

1.2 RESEARCH QUESTIONS

1. What is the prevalence of chelonian shell fracture cases reported to the veterinary teaching hospital in Klang Valley over the three years (2022-2024)?
2. What methods are used by the veterinarians in the veterinary teaching hospital in managing different types and severity of shell fractures?

1.3 RESEARCH HYPOTHESIS

1. Chelonian shell fractures have occurred with measurable prevalence in the veterinary teaching hospital over the period of 2022–2024.
2. The choice of shell fracture management method preferred by veterinarians at the veterinary teaching hospital is associated with the type and severity of the fracture.

1.4 RESEARCH OBJECTIVES

1. To determine the prevalence of chelonian shell fractures in veterinary clinics and hospitals in Klang Valley between the years 2022 and 2024.
2. To identify the methods employed by veterinary practitioners in repairing chelonian shell fractures in Klang Valley.

2.0 LITERATURE REVIEW

2.1 CHELONIA

Taxonomically, the order Chelonia is also referred to as Testudines or Testudinata, which consist of turtles, tortoises, and terrapins. In many parts of the world, turtles refer to marine chelonians, while terrapins refer to freshwater chelonians, and tortoises refer to terrestrial chelonians (Bayer & Innis, 2019). However, the interpretation of the three common names slightly differs in other regions of the world (Hornby et al., 2025). For example, in North America, all aquatic chelonians are referred to as turtles, except for one single species: the Diamondback Terrapin (*Malaclemys terrapin*) (Bayer & Innis, 2019). In Malaysia, the Turtle Conservation Society of Malaysia (TCS) groups chelonians into marine turtles, freshwater turtles, softshell turtles and tortoises (Chen et al., 2019).

2.2 CHELONIANS IN MALAYSIA

As of today, there is limited data recording the chelonian species specifically in Klang Valley. In Malaysia, however, 24 chelonian species have been recorded, including 4 sea turtle species, 11 freshwater turtle species, 4 softshell turtle species, 3 tortoise species, 1 invasive softshell turtle species *(Pelodiscus sinensis)* and 1 invasive freshwater turtle species *(Trachemys scripta)* (Mohd Salleh et al., 2022). Although none of these species have been declared extinct, only 3 species remain at lower risk of extinction, including *Trachemys scripta*, and no information is recorded in the IUCN list for *Pelodiscus sinensis* (Chen et al., 2019). While sea turtles and softshell turtles are predominantly protected and remain in their natural habitats, some freshwater turtles and tortoise species are commonly kept as pets.

2.3 GLOBAL TRENDS IN CHELONIAN OWNERSHIP AND COMMON CLINICAL PRESENTATIONS OF CHELONIANS IN VETERINARY CLINICS

Over the past 30 years, a significant increase in exotic pet ownership has been observed globally (Maguire et al., 2024). With this increasing trend of exotic pet ownership, tortoises and freshwater turtles are some of the most common exotic pets seen in a veterinary practice. A study in the United Kingdom in 2019 reported the common presentations of chelonians to veterinary clinics, which are beak abnormalities, overgrown nails and shell abnormalities, among which are shell fractures cases (Hornby et al., 2025). This study also reported that chelonian shell fractures is one of the most common presentations of chelonians to veterinary clinics. In another study in the United States, chelonian shell fracture is among the most commonly reported traumatic injuries of wild and captive chelonians in veterinary clinics, with wild chelonians being more widely affected (Roffey & Miles, 2018, Norton et. al, 2019). Shell fracture can be defined as the discontinuity of the carapace, plastron, and bridge, either separately or in combination, with or without exposure of the viscera (Fleming, 2008). These conditions can be caused by vehicular trauma, predation, falls, or poor husbandry practices (Norton et. al, 2019).

2.4 THE CHELONIAN SHELL

A chelonian's shell is made up of two main bony components, the dorsal carapace and the ventral plastron. Connecting the carapace and plastron on the sides is the bridge, with tough epidermal layers, or scutes lining the shell (Kirchgessner and Mitchell, 2009). Chelonians do not possess a sternum, so the ribs are embedded within the carapace. Except the cervical and caudal vertebrae, the chelonian vertebrae are fused and attached to the neural bones of the carapace (Kirchgessner and Mitchell, 2009). Aside from the stunning colours and patterns, species

variation in the anatomical structures of the Chelonian carapace also exists, where some have smooth carapace, and some have elevations, such as the Sulcata and Indian Star Tortoise. Some have leathery and soft carapace, such as the softshell turtles, while some have hard shells. This variation also exists to a lesser extent on their plastron. Box turtles, for example, have hinge joints in their plastron, allowing them to manipulate the closure of the gap between carapace and plastron, thus allowing them to protect their head and limb from predators. The variations in carapace and plastron characteristics across species, contribute to the challenges in managing shell fractures (Flanagan, 2015).

2.5 CHALLENGES IN MANAGING CHELONIAN SHELL FRACTURES

While the unique shell offers considerable protection to internal organs, it also complicates medical intervention. Veterinarians must consider not only the structural repair of the carapace or plastron but also any presence of coelomic involvement, internal organ damage, infection, head and spinal injury, loss of limb functions and life quality of the animal (Fleming, 2008). Additionally, shell fractures can be presented in various types and degrees of severity (Fowler, 2004). Due to their slow metabolism, chelonian shell fractures often require prolonged treatment (Fleming, 2008). Hence, the successful outcome of a shell fracture repair is defined not by the full restoration of the shell into its original structure, but by the ability of the animal to regain normal appetite, bowel, and urination (ABU), normal movement, can be discharged and continue at home treatment or rehabilitation (Fleming, 2008).

2.6 DIFFERENT PRESENTATIONS OF CHELONIAN SHELL FRACTURE

Chelonian shell fractures can present in various anatomical involvements, such as the carapace, plastron, bridge, or a combination of any of the three. To ease data collection and analysis, categories of anatomical involvement were developed for this study (see Table 1).

Currently, there is no standardised classification of fracture types in chelonian shells existing in literature. Some authors suggest that fracture types in chelonian shells can be classified as displaced, non-displaced, open, closed, or punctured (Norton et. al, 2019) while others grade the fractures based on the degree of severity (Fowler, 2024). To ensure uniformity and consistency, shell fractures in this study will be categorised into 6 types (Figure 1).

Types of shell fractures:

1. Open: Discontinuation of the shell with exposed bone and coelomic membrane or missing shell pieces. Open fractures can be displaced, non-displaced or punctured (Norton et. al, 2019, Fleming, 2008).
2. Displaced: Discontinuation of the shell with misalignment of shell pieces, exposing the bone and coelomic membrane.
3. Non-displaced: Discontinuation of the shell without misalignment of shell pieces, with or without exposed bone and coelomic membrane.
4. Puncture: Discontinuation of the shell with missing shell piece typically produced by predator bite, exposing the bone and coelomic membrane.
5. Closed: Discontinuation of the shell without exposed bone or missing shell pieces.
6. Mixed: Combination of 2 or more of the fracture types.

A. Open, displaced fracture (Fleming, 2008)

B. Open, non-displaced fracture (Fleming, 2008)

C. Closed fracture (Atoll, 2024)

D. Punctured shell shown by white arrow, and open, displaced fracture shown by black arrow (Norton et. al, 2019)

Figure 1: Types of chelonian shell fractures.

Chelonian shell fracture cases received in veterinary clinics often vary in the age of injury, which also plays a role in determining the management approach. Injuries less than 6 hours old are considered uncontaminated and non-infected, whereas injuries that are more than 24 hours old are considered contaminated. In some cases, chelonians presented with shell fracture also have head, spinal or limb injuries, exposure of internal organs and internal injuries. These different presentations are factors that should be considered when deciding on intervention as it determines the prognosis of the animal. Conveniently, a guideline to triage chelonian patients with shell fractures into 5 prognostic categories has been developed (see Table 2).

Table 1: Categories of anatomical involvement in chelonian shell fracture.

Category	Description
1	Carapace only
2	Plastron only
3	Bridge only
4	Carapace + Plastron
5	Carapace + Bridge
6	Plastron + Bridge
7	Carapace + Plastron + Bridge

Table 2: Classification of shell fractures and their expected prognosis.

Fracture characteristics	Prognosis
• Singular fracture • Non-displaced • Does not involve the spine • <6 hours • No other medical issues	Excellent
• Multiple fractures • Displaced • Shallow puncture	Good
• Missing large pieces of shell • Disruption of coelomic membrane • <24 hours old	
• Multiple fractures • Involves pectoral or pelvic areas. • Narrowing of pelvic canal in females that can be sterilized • Deep punctures • <24 hours old	Fair
• Missing large pieces of shell • Disruption of coelomic membrane	

• >24 hours old	
• Multiple fractures • Involves pectoral or pelvic areas • Deep punctures • >24 hours old	
• Open fractures • Punctures to the viscera • Significant blood loss	Guarded
• Exposure of viscera • Large amount of debris, dirt and maggots in fractured shell or limbs	
• Multiple fractures • Internal injuries • Head and spinal injuries • Complete loss of limb functions • Narrowing of pelvic canal in females that cannot be sterilized	Grave

2.7 CURRENT MANAGEMENT APPROACH

Upon presentation of the injured animal to the veterinary clinic, the condition and prognosis of the animal should be evaluated immediately. Diagnosis of shell fractures in chelonians are generally straightforward with physical examination, but diagnostic imaging such as radiography and computed tomography (CT) scan is often needed to assess the extent of injury, especially to the spine, head, neck, limbs and internal organs (Fleming, 2014). Complete blood counts (CBC) and serum biochemistry can also aid in assessing the patient's condition, determine prognosis and evaluate response to therapy. Once the diagnosis and prognosis is achieved, the decision of management approach should be made based on the severity of the condition, the animal's overall health, and the potential for recovery. The next approaches widely range from application of different bandage techniques, Vacuum-Assisted Closure (VAC) or external fixation with common hardwares to reduce the fracture.

1. **Supportive therapy:**

   In all patients with excellent to guarded prognosis, immediate stabilisation should proceed. This can be achieved with analgesics, fluid therapy if dehydration is evident, followed by wound irrigation, and if infection is present, antimicrobials should be administered (Fleming, 2014). Additionally, nutritional support through an esophagostomy tube should be established to maintain physiological functions and support the animal's overall recovery.

   Effective analgesics for chelonians include morphine, tramadol and meloxicam (Fleming, 2014). Chelonians generally can tolerate significant variation in fluid volume as they

have larger intracellular fluid volume compared to mammals. However, chelonians with shell fractures are considered to have significant fluid loss and insufficient fluid intake, leading to dehydration. Rehydration can be safely achieved with 10-25 ml/kg of commonly used fluid such as Lactated Ringer's (LR) solution, 0.45% sodium chloride (NaCl), and 2.5% Dextrose solution administered parenterally for the first day followed by per os route for a total duration of not more than 1 week.

Wound cleaning is commonly achieved by irrigating the wound with diluted chlorhexidine (2%) and sterile normal saline at a ratio of 1:2. However, prolonged use of Chlorhexidine (more than 1 week) is contraindicated and sterile normal saline should be used on its own (Fleming, 2014). In terms of antibiotics, broad-spectrum or gram-negative coverage antibiotics should be administered empirically until definitive results from bacterial culture and antibiotic sensitivity test (AST) are available to guide targeted treatment.

2. Bandaging

After ensuring that the wound is debrided of contaminants, bandaging can be performed. In cases of closed fractures, wet-to-dry bandage can be applied using gauze soaked with sterile saline, covered with dry gauze and secured with elastic tape. This bandage should be changed daily for one week, followed by topical application of silver sulfadiazene (SSD) ointment. In cases of severe infection, the silver impregnated gauze can be used. In cases of open fractures, wet-to-dry bandage should be performed initially, with daily replacement for the first two weeks. Then, non adherent dressing layered with gauze and

secured with tape can be performed, with twice a week changing for the next four to six weeks, until sufficient granulation tissue has formed. Then, the wound can be left unbandaged with occasional irrigation to keep it clean and monitored weekly.

3. **Vacuum - Assisted Closure (VAC)**

   VAC is a relatively new noninvasive technique that uses negative pressure to contract wound margins, encourage granulation, increases perfusion, removes exudate and reduces edema, resulting in faster wound healing (Fleming, 2014).

4. **Fracture fixation**

   Over the years, new materials and techniques in shell fracture fixation are continuously developing, allowing for achievement of chelonian shell fracture fixation even in resource-limited settings. Broken shells can be rearranged like puzzle pieces and fixed into place using several methods. Some authors have reported using adhesives, fiberglass, epoxy putty, stainless steel plates and screws, orthopaedic wires, cable tie, hooks and flat metal plates. However, in cases where the fracture is comminuted with missing pieces accounting for >30% of the shell, or if the fracture cannot be stabilised without the missing piece, the prognosis for the patient would be grave and fracture fixation is not efficient (Fleming, 2014). In another study, utilisation of orthodontic brackets with bonding agent was reported to produce a less messy outcome as compared to using epoxy/fiberglass material (Moore, 2003).

5. **Euthanasia**

Generally, chelonians with multiple fractures, accompanied by internal or head and spinal injuries have grave prognosis and should be euthanized (Norton et. al, 2019). Other than that, wild chelonians with shell fractures that involve complete loss of limb functions will have a poor survival chance post-intervention. These cases also warrant for euthanasia, unless the patient could be adopted into captivity. Important consideration needs to be taken in intact females with fractures in the pelvic region, as this may cause narrowing of the pelvic canal, subsequently leading to dystocia, coelomitis and death (Norton et. al, 2019).

In summary, existing literature highlights the anatomical complexity of the chelonian shell and the various causes, management approaches, and outcomes associated with shell fractures in other countries. Despite Malaysia's rich number of chelonian species, the published data on the prevalence and management of shell fracture cases locally is still lacking. This study seeks to investigate the prevalence and clinical management of shell fractures among tortoises, terrapins, and turtles presented to veterinary clinics and hospitals in the Klang Valley. By collecting, analysing and interpreting real-world data, this research aims to fill existing knowledge gaps, inform better clinical practices, drive future research ventures and support both conservation initiatives for chelonians in Malaysia.

3.0 METHODOLOGY

3.1 STUDY AREA

The study was conducted in the Klang Valley, Malaysia. The Klang Valley is one of the most rapidly urbanising regions in Peninsular Malaysia, encompassing Kuala Lumpur, Hulu Langat, Gombak, Petaling, and Klang (Ariffin et al., 2014).

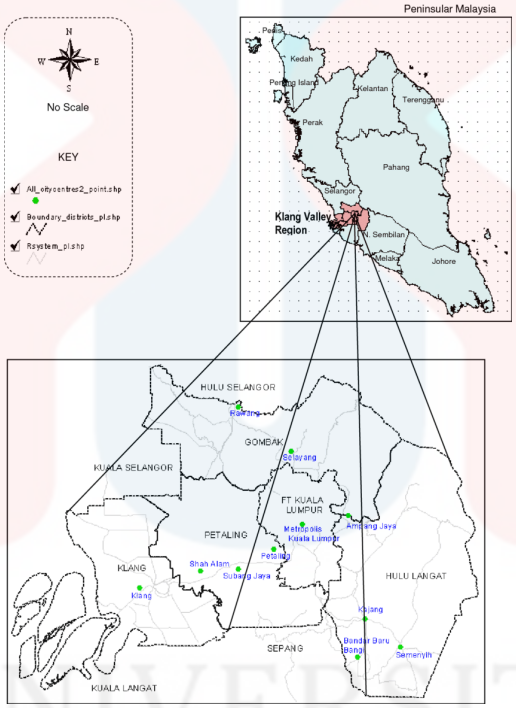


Figure 2: Map of Klang Valley districts.

3.2 STUDY DESIGN

Retrospective cohort study (2022-2024).

3.3 STUDY POPULATION

1. **Target population:** Chelonians with shell fractures in Klang Valley, within the years 2022-2024.
2. **Source population:** Chelonians with shell fractures that are brought to the veterinary clinics and hospitals in Klang Valley, within the years 2022-2024.
3. **Study population:** Chelonians that are diagnosed with shell fractures and managed in the veterinary teaching hospital, within the years 2022-2024.

3.4 SELECTION CRITERIA

3.4.1 INCLUSION CRITERIA

- Chelonians with shell fractures that were received, diagnosed and managed by the veterinary clinics and hospitals in Klang Valley, within the years 2022-2024.
- Veterinary clinics and hospitals that consent to access to patient data.

3.4.2 EXCLUSION CRITERIA

- Cases that have been referred to other clinics prior to diagnosis and management.
- Cases originating outside Klang Valley.
- Follow up cases originating from before the year 2022.
- Cases with shell deformities that are not fractures.

3.5 SAMPLING METHOD AND PROCEDURE

For this study, a purposive sampling method was used, targeting veterinary clinics and hospitals in Klang Valley that treat exotic animals. These institutions were identified by professional and social networking, online search, and clinic advertisements. The selected veterinary clinics and hospitals were contacted and invited to participate in the study. All recorded cases of chelonian shell fracture within the years 2022-2024 will be included in this study.

3.6 SAMPLE SIZE DETERMINATION

As there is currently limited formal data on the expected number of chelonian populations in Klang Valley nor Malaysia, determining the sample size and expected prevalence will be challenging. There is also a lack of studies on the prevalence of chelonian shell fractures carried out before. Hence, the standardised expected prevalence of 50% will be applied in this case.

Confidence level: 95%

Z score: 1.96

Level of significance: 0.05

Expected prevalence (P): 0.5

Sample size (*n*) = $(1.96/ 0.05)^2 \times 0.5 \times (1-0.5)$

$= 1536.64 \times 0.25$

$= 384.16$

A maximum of 385 cases will be needed for this study.

3.7 DATA COLLECTION TOOLS

1. **Research tool -** A standardized digital data collection form (Google Forms), will be used to gather comprehensive case details from participating veterinary clinics. The tool ensures consistency across cases while acknowledging that some records may be incomplete. Data will be anonymized and securely stored in a password-protected database. Pre-testing with sample cases will be conducted to ensure clarity and usability. To maintain reliability and minimise variability, all data will be collected by the same researcher.

   The data collection forms consist of three sections. Form A (Table 3) consists of questions about the general information of the clinic/ hospital in regards to chelonian patients. If the answers for both questions 1 and 2 are not 0, the clinic will be administered a set of follow-up questions, which are in Form B (Table 4). If the answers are 0 for both questions, no further data will be collected. However, if the clinic does not do record keeping, no further data will be collected from this clinic even if the answers for questions 1 and 2 are not 0, and this clinic will not be included in the study.

   Form B will be filled for each Chelonian patient presented in the clinic from 2022-2024 (eg: If 10 chelonians were presented to the clinic within the 3 years, 10 Google Forms will be filled by the researcher). If the answer for question 9 is/ includes shell fracture, the clinic will be administered a set of follow-up questions, which are in Form C (Table 5). Form C will be filled for each corresponding patient in Form B.

Table 3: Form A.

Form A (General Information)	
No.	**Question**
1.	How many chelonian cases were received in this clinic from 2022-2024? _____
2.	How many chelonian shell fractures has this clinic encountered from 2022-2024? _____
3.	How are patient records kept in this clinic? a. Kreloses b. Physical files c. Other d. No record keeping

Table 4: Form B.

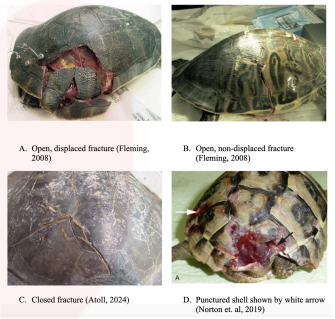
Form B (Patient Information) **Allocated ID (to be filled by researcher):** _____	
No.	**Question**
1.	**Group of chelonia** (Choose one answer): a. Tortoise b. Terrapin

	c. Turtle
2.	**Species** (If known): _____
3.	**Age group** (Choose one answer): a. Neonate b. Juvenile c. Adult d. Unknown
4.	**Sex** (Choose one answer): a. Male b. Female c. Unknown
5.	**Habitat** (Choose one answer): a. Wild b. Captive
6.	**District** where the animal was found (Choose one answer): a. Kuala Lumpur b. Shah Alam c. Petaling Jaya d. Subang Jaya e. Klang

	f. Selayang g. Ampang h. Kajang
7.	**Date** presented to the clinic (month and year): _____
8.	**Client complaint** (Choose all that applies): a. Shell fracture b. Other: _____

Table 5: Form C.

Form C (Shell Fracture Details) **Allocated ID (to be filled by researcher): _____**	
No.	**Question**
1.	Anatomical Area Affected (Choose one answer): a. Carapace only b. Plastron only c. Bridge only d. Carapace + Plastron e. Carapace + Bridge f. Plastron + Bridge

	g. Carapace + Plastron + Bridge
2.	Fracture type (Choose all that applies): a. Open, displaced b. Non-displaced c. Closed d. Punctured e. Mixed  A. Open, displaced fracture (Fleming, 2008) B. Open, non-displaced fracture (Fleming, 2008) C. Closed fracture (Atoll, 2024) D. Punctured shell shown by white arrow (Norton et. al, 2019)
3.	Suspected cause of fracture (Choose one answer): a. Vehicular trauma b. Predation c. Fall from height d. Mishandling e. Unknown f. Other: _____
4.	Other clinical conditions related to the fracture (Choose all that applies): a. Head and spinal injury b. Internal injury c. Pelvic injury d. Hemorrhage e. Respiratory distress f. Malnutrition

	g. Infection h. Metabolic bone disease i. None j. Other: _____
5.	Diagnostic methods used to diagnose fracture and decide on further intervention (Choose all that applies): a. Physical examination b. Radiography c. MRI/ CT Scan/ Ultrasound d. Bacterial culture & AST e. Hematology & Serum Biochemistry f. Other: _____
6.	Management of the case: a. Stabilization b. Wound cleaning c. Bandaging d. Fracture fixation e. Euthanasia f. Other: _____
7.	Elaborations for answers to question No. 11 (if fracture fixation, what kind of fixation, if stabilisation, what are the aids used, if euthanasia, what are the drugs/ methods used):

	_____
8.	Number of days hospitalised: _____
9.	Outcome: a. Discharged b. Euthanised c. Died

3.8 DATA ANALYSIS

Data collected was entered and analyzed using Microsoft Excel. Cases were separated into years of admission. Each row represents a case, and each column a variable, based on the collected data. Data was cleaned to manage missing, or inconsistent entries. Anonymized IDs were used for each case to ensure confidentiality. All data handling follows standard ethical and data protection guidelines.

Descriptive Analysis:

1. Prevalence of chelonian shell fracture in the veterinary clinics and hospitals in Klang Valley (2022-2024).
2. Management methods for chelonian shell fracture practiced by the veterinary clinics and hospitals.

3.9 ETHICAL CONSIDERATIONS

This study involves the retrospective review of clinical records from the veterinary clinics and hospitals, hence no ethical approval is needed. As the data are observational and based on existing records, the study poses minimal to no risk to animals or humans. Participation by the veterinary clinics and hospitals is voluntary, and permission to access the records will also be obtained. All data will be used solely for academic purposes, handled with strict confidentiality, and stored securely in password-protected digital files.

4.0 RESULTS

Out of all veterinary clinics and hospitals that were approached, only one veterinary hospital met the inclusion criteria, which is University Veterinary Hospital, Universiti Putra Malaysia (UVH UPM). Chelonian patient records from the years 2022-2024 were collected from the veterinary teaching hospital. A total of 123 patients were received within the 3 years, with 47 patients received in 2022, 55 patients in 2023, and 21 patients in 2024 (Table 6).

Out of 123 patients, four of them were presented with shell fractures, describing a prevalence of 3.25%. Other than shell fracture, there were 26 other clinical conditions of chelonians at the teaching hospital, with some patients having more than 1 health issue at presentation. The most common presentation is respiratory tract diseases (30.9%), followed by general health checkup (15.17%). Unspecified metabolic bone diseases make up 12.36% of the cases, while egg binding, shell deformity, and osteoarthritis make up 3.93%, 2.25%, and 1.69% of the cases respectively. 1.12% of the records state that the reason for visitation was to check the eggs, while 5.09% were due to soft tissue injury due to fighting. Other reasons for hospital visitation are summarised in Table 7, where the total number is more than 123 because some chelonians are presented with multiple health issues.

The individual files of patients with shell fracture were assessed to obtain the patient signalment, history, physical examination findings, diagnostic workup performed and clinical interventions conducted to manage the case. From the files, it is determined that three of the patients were tortoises while the other one was a terrapin. All of the patients were captively reared in common households. From the history, the causes of the shell fracture were identified, where vehicular

accidents account for 50% (n=2), fall from height is 25% (=1), while the cause of fracture for the other patient was not recorded.

Diagnostic methods for cases of chelonian shell fracture practised by the clinicians include physical examination and radiography. Radiography was performed in 75% (n=3) of the cases to assess the involvement of vertebral or limb fractures. The types of shell fracture were classified based on the exposure of the coelomic cavity and displacement of fractured segments upon physical examination findings. Description recorded by the attending veterinarian reveals open, displaced fracture (n=3) and closed fracture (n=1). Other physical examination findings associated with the fracture include dull temperament (n=4), hindlimb weakness (n=1) as well as a combination of hematemesis, epistaxis, hematochezia, and breathing difficulty (n=1).

Clinical management of chelonian shell fracture in this veterinary teaching hospital include wound cleaning (n=2), stabilisation with fluid therapy (n=2), antibiotics and analgesics (n=3), and fracture fixation with epoxy glue (n=2), while non-specific surgery is recorded for 1 of the patients. 2 out of 4 patients were discharged and presented for follow up appointment, while no outcome was recorded for 2 other patients. A summary of the findings is recorded in Table 8.

Table 6: Number of chelonian patients presented to the veterinary teaching hospital recorded by year.

Year	Number of Chelonian admitted
2022	47
2023	55
2024	37
Total	**123**

Table 7: Presentations of chelonians in the veterinary teaching hospital from 2022-2024.

Presentation	Frequency	Percentage (%)
General health check up	27	15.25
Shell fracture	4	2.26
Soft Tissue Injuries	9	5.08
Respiratory Tract Diseases	55	31.07
Metabolic Bone Diseases - unspecified	22	12.43
Egg Retention	7	3.95
Osteoarthritis	3	1.69
Shell Deformity	4	2.26
Check eggs	2	1.13
Aural abscess	6	3.39
Mandibular abscess	1	0.56
Eye infection	7	3.95
Pododermatitis	2	1.13
Inguinal mass	1	0.56
Septicemic Cutaneous Ulcerative Disease	2	1.13
Cystitis	1	0.56
Urolithiasis	6	3.39
Hypovitaminosis A	4	2.26

Inappetent	1	0.56
Dietary intolerance	1	0.56
GI Obstruction	5	2.82
Constipation	2	1.13
Gastritis	1	0.56
Cloacal prolapse	1	0.56
Rectal prolapse	1	0.56
Hemipenile collapse	1	0.56
Uterine prolapse	1	0.56
TOTAL	**177**	**100.00**

Prevalence of Chelonian Shell Fractures

4/123 x 100% = 3.25%

Table 8: Summary of the chelonian shell fracture cases occurring in the study.

ID	Species	Habitat	Cause of Fracture	Diagnostic Methods	Fracture Type	Fracture Location	Other Conditions	Clinical Management	Fixation Method	Patient Outcome	Post-treatment Complication
1	Tortoise	Captive	-	Physical examination, Radiography	Open, nondisplaced	Carapace	-	Antibiotic, Opioid, NSAID, fluid therapy, wound cleaning, fracture fixation	Epoxy Glue	-	-
2	Tortoise	Captive	Vehicular trauma	Physical examination	Open, nondisplaced	Carapace and bridge	Dull mentation	Surgery	-	-	-
3	Tortoise	Captive	Vehicular trauma	Physical examination, Radiography	Closed	Carapace	Bright mentation, hindlimb weakness	Antibiotic, Opioid, fluid therapy	-	Discharged	Fungal infection
4	Terrapin	Captive	Fall from height	Physical examination, Radiography	Open, nondisplaced	Plastron and bridge	Hematemesis, Epistaxis, Hematochezia, Dyspnea, Inappetance	Antibiotic, NSAID, wound cleaning, fracture fixation	Epoxy glue	Discharged	-

5.0 DISCUSSION

The findings of this study demonstrate that chelonian shell fracture cases presented to UVH UPM occurred at a relatively low prevalence (3.25%), with only four cases identified out of 123 chelonian presentations over a three-year period. This very small sample size is comparable to trends reported in other veterinary settings, where traumatic chelonian injuries constitute a small yet clinically important subset of reptile cases. The low case number likely reflects the limited population of captive pet chelonians in the surrounding community, the underreporting of injuries in free-ranging individuals, and the possibility that many owners may not seek veterinary care for reptile trauma due to lack of awareness or logistical challenges.

Due to the small number of cases recorded, this study was restricted to the use of descriptive statistics rather than inferential analyses. While descriptive findings are valuable for establishing baseline patterns, they do not allow for statistical testing of associations or risk factors. As a result, conclusions drawn from this dataset must be interpreted cautiously. For example, while vehicular trauma appeared to be the leading cause (50% of cases), the sample size is too small to infer true prevalence or distribution of trauma mechanisms among chelonian populations in Malaysia. This limitation underscores the need for larger-scale or multicentre data collection to enable more robust epidemiological analysis in future research.

The majority of affected animals in this study were tortoises, mirroring international patterns where tortoises constitute a large proportion of captive chelonians. All cases were from captively reared individuals, highlighting that trauma risks within domestic environments remain clinically relevant. Vehicular trauma and accidental falls were identified as the causes of the captive

chelonian shell fracture, reinforcing the importance of owner education on chelonian safety and enclosure management. One case lacked a recorded cause, reflecting challenges in retrospective data quality and incomplete history-taking.

Diagnostic approaches relied primarily on physical examination and radiography, which are consistent with recommended protocols for evaluating chelonian trauma. Radiographs were taken in 75% of cases to assess concurrent injuries, though the absence of advanced imaging modalities such as CT limited detailed evaluation of internal damage. The fractures observed were predominantly open, nondisplaced types, which generally require careful management due to the risk of contamination, infection, and disruption of the shell's protective function. Associated clinical signs including dull mentation, hindlimb weakness, and systemic bleeding indicate that shell fractures frequently occur alongside systemic compromise, particularly when high-impact trauma is involved.

The clinical management strategies employed by the veterinarians in UVH UPM, such as wound cleaning, fluid therapy, analgesics, antibiotics, and the use of epoxy glue for shell repair are consistent with established chelonian trauma care protocols. Epoxy glue remains a practical and widely accessible method for stabilising shell defects, particularly in mild to moderate fractures. However, the limited follow-up data, with only two cases returning for reassessment, restricts interpretation of long-term healing outcomes and treatment success. This loss to follow-up is a common limitation in retrospective veterinary studies and further reduces the ability to analyse patient prognosis comprehensively.

6.0 CONCLUSION AND RECOMMENDATIONS

This study establishes the baseline data on the prevalence and management of chelonian shell fracture cases in UVH UPM over a three-year period (2022-2024). Shell fractures were found to be uncommon, representing only 3.25% of all chelonian presentations during the study period, with most injuries resulting from preventable causes, particularly vehicular trauma and fall from height. The small number of cases limited the study to descriptive analysis; however, the findings reveal patterns consistent with global reports, including the significance of vehicular trauma, and the reliance on physical examination and radiography for diagnosis. Management approaches such as wound cleaning, fluid therapy, analgesics, antibiotics, and epoxy-based fracture repair were aligned with established clinical practices. Although the low prevalence restricts broader epidemiological interpretation, the study provides a foundational reference for chelonian trauma cases within a Malaysian veterinary teaching hospital and highlights the need for expanded future research.

The findings highlight that while chelonian shell fracture cases are relatively rare, they require prompt and comprehensive veterinary care due to the potential severity of associated injuries. The study also identifies gaps in documentation, follow-up compliance, and preventive owner education.

Based on the findings of this study, it is recommended that diagnostic protocols for chelonian trauma be standardised so that radiographic evaluation becomes a routine component of assessment, allowing early detection of internal injuries and associated fractures. In addition, developing a structured treatment guideline for shell fracture management would help ensure

consistency in wound care, analgesia, antibiotic use and the selection of appropriate fixation methods. To support these improvements, medical record documentation should be strengthened, ideally through the introduction of a chelonian-specific clinical template that captures all essential information. Improving follow-up compliance is also important, and this may be achieved through scheduled reminders or more structured post-treatment communication with owners. Furthermore, targeted public education is necessary to reduce preventable injuries by promoting secure enclosure systems, proper supervision and safer husbandry practices, as well as raising awareness on the importance of seeking immediate veterinary care when trauma occurs. Finally, future research should consider expanding the sample size through multicentre collaborations, evaluating long-term outcomes of various repair techniques and exploring differences between captive and wild chelonians to gain a more comprehensive understanding of national trends and prognosis.

7.0 REFERENCES

1. Abdul Rashid, M. F., & Ab. Ghani, I. (2009, January). The Importance Of Internal Migration: In The Context Of Urban Planning Decision Making. Research Gate. Https://Www.Researchgate.Net/Publication/260481175_the_importance_of_internal_migration_in_the_context_of_urban_planning_decision_making
2. Ariffin, A. H., Solah, M. S., Hamzah, A., Paiman, N. F., Isah, N., Mohd Jawi, Z., & Abu Kassim, K. A. (2014). Seatbelt Reminder (Sbr) In Asean New Car Assessment Programme (Asean Ncap) Rating: Supportive Findings From A Case Study Of Seatbelt Wearing In Klang Valley, Malaysia. Australian Journal Of Basic And Applied Sciences, 136–143.
3. Atoll, S. (2024, September 22). *Oekaashi - Turtle Rescue & Rehabilitation In The Maldives*. Marine Savers. Https://Marinesavers.Com/Turtles/Oekaashi/
4. Bayer, T. H., & Innis, C. J. (N.D.). Chelonian Taxonomy, Anatomy, And Physiology. In Mader's Reptile And Amphibian Medicine And Surgery (Pp. 31–35). Essay, Elsevier.
5. Chen, P. N. (2020, May 15). 6 Reasons You Should Not Keep A Pet Turtle. Turtle Conservation Society Of Malaysia. Https://Www.Turtleconservationsociety.Org.My/6-Reasons-You-Should-Not-Keep-A-Pet-Turtle/
6. Chen, P. N., Lim, W. L., Shepherd, L. A., & Teo, E. W. (2019). Turtles Of Malaysia (2019). Malaysia Biodiversity Information System (Mybis). Https://Www.Mybis.Gov.My/Pb/4503
7. Fleming, G. (N.D.-A). New Technique In Chelonian Shell Repair. In Current Therapy In Reptile Medicine And Surgery (Pp. 205–212). Essay, Elsevier.

8. Fowler, A. (2004, July 27). Common Presentations Of Injured Native Turtles. Australian Wildlife Rehabilitation Conference. Https://Www.Awrc.Org.Au/Uploads/5/8/6/6/5866843/Nwcc-Fowler-040727.Pdf
9. Hornby, J. M., Hedley, J., Brodbelt, D. C., Church, D. B., & O'neill, D. G. (2025). Demography, Commonly Recorded Disorders And Mortality In Chelonia Under Uk Primary Veterinary Care: A Vetcompass Study. Plos One, 20(4). Https://Doi.Org/10.1371/Journal.Pone.0321038
10. Maas, A. (2024, June 21). Presenting Problem: Shell Fractures In Chelonians. Lafebervet. Https://Lafeber.Com/Vet/Presenting-Problem-Shell-Fractures-In-Chelonians/?Srsltid=Afmboopx7jbruyv6c7ixbfbzmyy4zhliktxfiapyerwsere4jcxibwmy
11. Maciel, E. (2024, April 18). The Business Of Exotic Pets: An Update. Globalpets. Https://Globalpetindustry.Com/Article/The-Business-Of-Exotic-Pets-An-Update/
12. Maguire, R., Lim, Q. A., & Bin Ahmad, A. A. (2024). Exotic Animal Practice In Southeast Asia. Veterinary Clinics Of North America: Exotic Animal Practice, 27(3), 533–549. Https://Doi.Org/10.1016/J.Cvex.2024.03.007
13. Mohd Salleh, M. H., Esa, Y., Salleh, S. M., & Mohd Sah, S. A. (2022, August 25). Turtles In Malaysia: A Review Of Conservation Status And A Call For Research. Mdpi. Https://Www.Mdpi.Com/2076-2615/12/17/2184
14. Msava Member Vet Clinics. Msava. (2023, March 10). Https://Msava.Org/Msava-Member-Vet-Clinics/
15. Red-Eared Slider. Invasive Species Centre. (2022, January 11). Https://Www.Invasivespeciescentre.Ca/Invasive-Species/Meet-The-Species/Land-And-Animal-Invertebrates/Red-Eared-Slider/

16. Roffey, J., & Miles, S. (2018). Turtle Shell Repair. In Reptile Medicine And Surgery In Clinical Practice (Pp. 397–408). Essay, Wiley Blackwell.

17. Tan, H. Y. (2023, November 23). Exotic Pet Trend In Thailand Raises Concerns Over Wildlife Protection. The Star. Retrieved From Https://Www.Thestar.Com.My/Aseanplus/Aseanplus-News/2023/11/25/Exotic-Pet-Trend-In-Thailand-Raises-Concerns-Over-Wildlife-Protection.