
Wound Healing in Captive Asian Elephants: An Animal Welfare Concern

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Abstract

Asian elephants (*Elephas maximus*) in captivity are more susceptible to skin injuries, usually aggravated by unscientific management practices. These wounds, if left untreated or improperly managed, can become chronic, challenging the overall health and welfare of these animals. From the welfare point of view, we investigated the conditions that influenced wound healing outcomes. Over three years (2019–2022), we employed a multi-modal assessment approach, integrating wound mapping (ArcGIS Pro), smartphone-based digital planimetry (imito app), and infrared thermography (IRT) for objective wound evaluation among captive elephants of south India. Metagenomic sequencing provided insights into microbial diversity, while protease activity analysis was used to determine factors contributing to chronic wound persistence. Of the 202 elephants under this study (under different ownerships like private, temple or forest), wounds were significantly more prevalent, particularly in those housed in tethered conditions. In contrast, elephants in forest camps exhibited improved wound healing, likely due to the availability of scientific veterinary care in the camps. Scientific wound management we provided facilitated healing in 75% of selected chronic cases within 56 days. Digital planimetry minimised measurement errors, while metagenomic analysis identified polymicrobial infections from human, animal, and environmental sources. The presence of antibiotic-resistant isolates underscored the urgent need for judicious antimicrobial use. All results pointed out the need for a scientific wound management protocol, including point-of-care diagnostics, proper medications, adherence to scientific principles, and an animal-friendly approach. Our findings emphasize the importance of structured veterinary care, digital diagnostics, and behaviour-compatible wound management to ensure animal welfare, as welfare is the biggest concern about the survival of this majestic species. Future research should focus on individualized health monitoring, alternative wound protection strategies, and mitigating anthropogenic stressors to enhance captive elephant welfare and conservation efforts.

Keywords: Asian elephant, Animal welfare, Skin wound, Wound management,
Digital diagnostics

Introduction

The Asian elephant (*Elephas maximus*), an iconic keystone species, has long been integral to South and Southeast Asia's cultural and religious traditions. However, the domestication and captivity of these gentle giants introduce complex challenges, particularly concerning their health and welfare. Among the myriads of concerns faced by captive elephants, skin wounds represent a significant yet often overlooked welfare issue. Captive conditions frequently subject elephants to injuries that stem from inadequate husbandry practices, tethering, improper harness use, or prolonged standing on unsuitable substrates (Mumby & Plotnik, 2018). When these wounds remain untreated or are poorly managed, they can become chronic, leading to pain, infection, and long-term physiological and psychological distress. Addressing these concerns is paramount not only for the individual well-being of these animals but also for the broader conservation and ethical implications of elephant captivity.

The process of wound healing in elephants is a multifaceted physiological phenomenon influenced by intrinsic and extrinsic factors such as nutrition, immune response, environmental conditions, and human interventions. Unlike their wild counterparts, captive elephants often experience compromised wound healing due to restricted movement, heightened stress levels, and exposure to novel pathogens, exacerbated by human-mediated factors (Vanitha et al., 2011). Despite these challenges, limited research exists on the specific wound healing patterns in elephants, particularly those in managed care. Moreover, conventional wound management strategies applied to captive elephants often lack scientific rigour, relying heavily on anecdotal knowledge rather than evidence-based protocols (Fowler & Mikota, 2006).

Given these gaps, our study sought to comprehensively investigate the wound-healing process in captive Asian elephants from a welfare perspective. We aimed to identify key determinants affecting healing outcomes and develop a data-driven approach to enhance veterinary management. Central to our methodology was the integration of advanced diagnostic tools, including digital wound mapping, infrared thermography (IRT), and metagenomic sequencing, to generate objective, reproducible data. The application of these technologies represents a transformative step in veterinary care, providing precise insights into wound progression and the microbiome composition of chronic wounds.

Materials and Methods

The research was conducted on captive Asian elephants (*Elephas maximus*) presenting with cutaneous wounds, reported to the Veterinary Hospitals of Kerala Veterinary and Animal Sciences University at Kokkalai and Mannuthy, as well as various elephant camps within and outside Kerala from September 2019 to October 2022. To facilitate systematic investigation, the study was structured into multiple phases: screening captive elephants for wounds and scars, monitoring the healing process, identifying chronic wounds, collecting relevant biological samples, and implementing a wound treatment protocol. The collected data were analysed, and the results were interpreted and discussed.

To ensure ethical research practices, the privacy of the animals was maintained by assigning unique identification codes to wounds. Prior to initiating the study, necessary permissions were obtained for wound and scar mapping and the collection of biological samples from captive elephants under the jurisdiction of the Kerala Forests and Wildlife Department. Additionally, clinical cases from devaswoms and private ownership were attended to upon request from the custodians, with informed consent obtained from the relevant authorities.

Standardised high-resolution digital photographs (capturing frontal, rear, and lateral views) were utilised for the identification and documentation of wounds and scars on the elephants. Retrospective treatment data spanning August 1986 to September 2019 were reviewed to assess treatment outcomes, wound duration, and healing efficacy in three different elephant camps. The recorded wound duration was used to determine the mean percentage of wounds healed over specific timeframes, following the methodology outlined by Robson et al. (2000).

Among the 29 reported cases, 12 elephants with wounds persisting beyond eight weeks or failing to exhibit healing within this period were selected for in-depth analysis. Key observations regarding factors influencing wound healing and emerging complications during the study were meticulously documented for future reference. Particular attention was given to complications encountered during wound management and treatment. Cases requiring extended treatment beyond the observation period were recommended for continued follow-up care. Based on the study findings, a comprehensive wound management protocol was formulated, incorporating the observed results and best practices derived from the research.

Results and Discussion

The study was conducted on captive Asian elephants (*Elephas maximus*) from September 2019 to October 2022, focusing on wound occurrence, healing trajectories, and factors influencing chronic wounds. Screening 202 elephants for cutaneous wounds and scars. The research spanned southern states of India, covering 11.3% of the total national captive elephant population as per 2019 census (DAHD, 2020). Understanding the factors influencing wound healing in captive elephants is crucial, given that these animals are frequently subjected to unscientific management practices contributing to chronic wounds. This study provides significant insights into elephant health and welfare, with implications for improving veterinary interventions and husbandry practices.

The prevalence of wounds in captive elephants is a major welfare concern, reflecting the challenges associated with their management. Among the 202 elephants screened, 29 were found to have cutaneous wounds, with a higher incidence in males. This trend is likely attributed to the prolonged restraint and tethering required during musth periods, characterised by heightened aggression and hormonal fluctuations (Gogoi et al., 2017; Ghimire et al., 2022). The impact of inadequate housing conditions, such as prolonged tethering and exposure to unsanitary environments, further exacerbates the risk of developing chronic wounds. The study identified distal limbs as

the most commonly affected sites, corroborating previous findings that suggest foot and limb injuries are prevalent in captive elephants subjected to restrictive movement (Mikota, 2006; Angkawanish et al., 2009). Poor flooring conditions, improper guide devices, and interactions with rough surfaces contribute to skin trauma, emphasising the need for enhanced management strategies to mitigate injury risks. Healing trajectories were monitored using a combination of digital planimetry, infrared thermography (IRT), and systematic clinical evaluations. Among the 29 cases, 12 wounds were classified as chronic, persisting beyond eight weeks without significant improvement. This observation aligns with previous studies indicating that normal wound healing in elephants typically occurs within two months (Giridas, 2011; Senthilkumar et al., 2014; Basha et al., 2016). However, chronic wounds presented a delayed healing response, requiring targeted intervention strategies. Scientific wound management facilitated healing in 75% of chronic cases within 56 days. The use of digital planimetry minimised measurement errors, while IRT provided objective assessments of inflammation and tissue viability (Rekant et al., 2016). These advanced diagnostics allowed for the early detection of factors impeding wound healing, reinforcing the importance of evidence-based approaches in veterinary care. Metagenomic sequencing of wound fluid samples revealed a diverse microbial community, with bacterial strains originating from human, animal, and environmental sources. This highlights the complex interactions between captive elephants and their surroundings, where exposure to contaminated water, improper wound management, and frequent human-animal interactions contribute to microbial diversity (Barman et al., 2013; Cheong & Kalan, 2019). The presence of antibiotic-resistant isolates in wound microbiomes is particularly concerning, as it underscores the growing challenge of antimicrobial resistance in veterinary medicine.

Antibiogram studies revealed resistance to commonly used antibiotics, necessitating the development of alternative treatment strategies. Given the emergence of antibiotic-resistant bacteria, the study emphasises the need for judicious antimicrobial use, targeted therapies, and enhanced infection control measures in elephant wound management. The study observed a wide variation in wound treatment approaches, with 27.59% of cases managed using traditional or ayurvedic methods, 34.48% with modern medicine, and 37.93% through an integrative approach combining multiple modalities. Traditional methods, including the use of honey and herbal extracts, have been historically employed in wound care but lack standardised scientific validation (Dai et al., 2018; Rajeev et al., 2020). Scientific wound management in the study incorporated thorough wound cleansing, debridement, and controlled medication application to facilitate healing. A significant challenge was the inability to use conventional bandaging techniques due to elephant behaviour, as they often remove dressings using their trunks (Mikota, 1993; Nath et al., 2011). This necessitates the exploration of alternative protective measures, such as medicated sprays or bio-compatible wound coverings tailored for elephants. IRT emerged as a valuable non-invasive diagnostic tool for assessing wound inflammation and pain levels. Thermal imaging allowed for the visualisation of temperature variations in wound sites, enabling

early identification of infected or non-healing wounds (Szentkuti et al., 2011; Chaves et al., 2015). Pain detection using IRT was particularly beneficial in guiding handlers on safe approaches to treatment, reducing the risk of adverse animal reactions. The findings underscore the need for a paradigm shift in captive elephant management, advocating for a science-based, welfare-oriented approach. The study highlights several key recommendations:

1. **Improved Housing and Management Practices:** Elephants should have increased access to unrestricted movement, running water, and hygienic living conditions to reduce wound incidence.
2. **Standardized Wound Treatment Protocols:** A structured approach to wound management, integrating digital diagnostics, targeted antimicrobial use, and evidence-based interventions, should be adopted.
3. **Alternative Protective Strategies:** Research into non-invasive wound coverings and remotely administered medications is necessary to address the limitations of traditional bandaging.
4. **Enhanced Veterinary Training:** Capacity building for veterinary professionals in advanced wound care, diagnostics, and microbiome analysis will contribute to better treatment outcomes.
5. **Monitoring Human-Animal Interactions:** Given the role of human contact in wound contamination, stricter biosecurity measures should be enforced in elephant care facilities.

Conclusion

Over three years (2019–2022), we conducted a longitudinal study involving 202 elephants housed across diverse captive environments in South India. This holistic, multi-modal approach allowed us to identify critical factors influencing healing rates and propose a structured, scientifically robust wound management protocol tailored for elephants in managed care. These efforts will be instrumental in advancing captive elephant welfare and conservation initiatives, reinforcing the necessity for data-driven veterinary care in the management of these majestic animals. In doing so, this research enhances our understanding of wound healing dynamics and reinforces the ethical responsibility of ensuring optimal welfare standards for these sentient beings. Future studies should build upon this foundation by exploring alternative wound protection strategies, refining point-of-care diagnostics, and addressing anthropogenic stressors that impede healing, ultimately contributing to improved well-being and longevity of captive Asian elephants. Future research should explore the development of innovative, species-specific therapeutic strategies to enhance wound healing while ensuring ethical and humane management practices.

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