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Speedy Recovery of Subcutaneous Abscess and The Presence of Overgrown Nails in A Pygmy Hedgehog: A Case Report

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Abstract

This study reported that a 15-month-old intact female African pygmy hedgehog (*Atelerix albiventris*) was presented to IPB University Veterinary Teaching Hospital to evaluate a 1.5 cm × 1.5 cm × 0.5 cm mass on the left ventral thorax, three days after the mass was first discovered by the owner. Overgrown nails were observed on all four toes of each of the four limbs of the hedgehog. The body weight was 150 g, and the axial temperature was 36.5°C. The heart and respiratory rates were 180 per minute and 40 per minute, respectively. After a thorough physical examination, the patient was diagnosed with subcutaneous abscesses and overgrown nails. The abscess was surgically resected using a local anesthetic. The overgrown nails were trimmed to prevent further injury and the recurrence of abscesses. Following surgery, the hedgehog was discharged directly from the hospital and treated using Amoxicillin 15 mg/kg per oral every 12 hours for seven days, daily routine wound cleaning with sodium chloride, and topical powder of neomycin sulfate 5 mg/g and bacitracin 250 IU/g. The patient responded effectively to the systemic treatment, and medical signs and symptoms resolved. The hedgehog fully recovered from the subcutaneous abscess 14 days after the first hospital visit. No recurrence was reported in the subsequent month after resolution.

Keywords: African pygmy hedgehog, overgrown nails, pus-filled bumps

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INTRODUCTION

The four-toed African pygmy hedgehog, also known as the white-bellied hedgehog (*Atelerix albiventris*), is a small mammal that feeds on insects and is native to Africa (Heatley, 2009). This species of hedgehog has a wide geographical distribution, including Asia, Europe, and Africa (Simone and Hoefer, 2004). While they are frequently used in biomedical research, they are also gaining popularity in the exotic pet industry (Wissink, 2020).

The characteristics of a pygmy hedgehog include spines on the upper coat and a white, hairy underbelly. Pygmy hedgehogs in captivity typically weigh between 250 and 700 g. Their lifespan in captive environments can reach up to ten years, with an average of 5 to 7 years (Simone and Hoefer, 2004). These small mammals spend their daytime hours in caves, bushes, or logs, but as nocturnal creatures, they are active at night for foraging and often cover vast distances in search of food or potential mates (Wissink, 2020; Hedley, 2014).

Although they are classified as insectivores, pygmy hedgehogs are true omnivores. They primarily consume invertebrates such as insects, snails, earthworms, slugs; and small vertebrates e.g. lizards, frogs, and snakes. Pygmy hedgehogs also consume small amounts of plant materials, including fruits and vegetables (Wissink, 2020).

Several diseases commonly reported in pet pygmy hedgehogs include skin diseases e.g. ectoparasites, dermatophytosis, and trauma; gastrointestinal diseases e.g. squamous cell carcinoma, dental disease, enteritis, hepatic lipidosis, obesity, oral foreign body, megaoesophagus, pyloric and intestinal obstruction; skeletal diseases e.g. spondylosis, annular pedal constriction, and degenerative joint disease; respiratory diseases e.g. upper respiratory tract disease and pneumonia; cardiac

diseases e.g. valvular endocarditis and dilated cardiomyopathy; ophthalmic diseases e.g. ocular proptosis and corneal ulcers; urogenital and reproductive diseases e.g. chronic kidney disease, hematuria, posthitis, uterine disease, urolithiasis, and cystitis; neurologic diseases e.g. Wobbly hedgehog syndrome, heat stroke, and intervertebral disk disease; and tumors e.g. intra-abdominal and systemic neoplasia, skeletal neoplasia, oral neoplasia, integumentary neoplasia (Keeble and Koterwas, 2020; Maguire and Zanten, 2021; Lee, 2021; Graham *et al*., 2021; Ramadita and Paramita, 2019). Neoplasia or tumors are potential differential diagnoses in all sick hedgehogs because they are relatively common in this species (Prastika *et al*., 2020; Maguire *et al*., 2021).

Given the propensity for obesity in captivity, it is crucial to ensure that the diet of pygmy hedgehogs is low in fat. Because this species tends to become obese when kept in captivity, regular weight checks should be a part of every clinical check-up. Regular health checks are advised to identify issues early since disease symptoms can be easily concealed (Hedley, 2014). This case study was the first to report the occurrence of overgrown nails and the speedy recovery of a subcutaneous abscess in a pet African pygmy hedgehog from Indonesia.

MATERIALS AND METHODS

Study Period and Location

A pygmy hedgehog was brought to the Veterinary Teaching Hospital of IPB University by the owner on the 10th of April, 2023, with an enlarged mass on the left ventral side of the thorax. Home treatment with antibiotics for 7 days and wound treatment for 14 days was performed and the patient responded effectively. The hedgehog fully recovered from the subcutaneous abscess fourteen days after the first hospital visit. No reoccurrence was informed in the subsequent month after resolution.

Anamnesis

The veterinarian learned that the owner had noticed the lump or an enlarged mass three days before the hedgehog was presented for evaluation at the veterinary hospital. The hedgehog was reared as a single pet hedgehog. The types of feed the owner gives the hedgehog were commercial dry cat food and mealworms. The patient had been purchased from a pet shop six months before being brought to the veterinary hospital. The hedgehog cage was a 60 cm x 30 cm x 5 cm aquarium with shredded paper and a pee pad as bedding, tofu litter as the toilet, and one pouch for shelter.

Physical Examination and Diagnosis

The procedure of physical inspection of the hedgehog was carried out with manual restraint without administering anesthesia with the owner's help. The body weight was 150 g, and the axial temperature was 36.5°C. Rectal temperature cannot be measured as the small size of the anal cavity of the pygmy hedgehog. The heart and respiratory rates were 180/minutes and 40/minutes, respectively. The apparent clinical signs shown by the patient were the long-curled nails from all the hind and fore legs (Figures 1 and 2) and the enlarged mass of 1.5 cm x 1.5 cm x 0.5 cm (Figure 2). The veterinarian observed that slimy white matter came out from the lump, considered as pus, further palpated, and noticed that the swelling mass was soft and movable. Thus, the veterinarian injected Lidocaine around the bump and did a fine needle aspirate using a butterfly needle. During the aspiration, white slime matter came out from the lump, and the skins at the outer part of the lump were already detached. Thus, the veterinarian diagnosed the hedgehog with subcutaneous abscesses and overgrown nails.

Treatment

The veterinarian treated the hedgehog's abscess by performing abscess cleaning and nail clipping. As soon as the abscess was confirmed, the veterinarian cleaned the affected areas and the wound. The cleaning procedure was conducted using aseptic techniques and Lidocaine, with careful handling. Before cleaning the wound, an inspection was conducted, and surrounding hairs were clipped. Following this, a 10% povidone-

iodine solution was applied to the surface of the abscess. Both the veterinarian and the handler wore gloves.

Initially, a 21G needle and syringe were used in an attempt to aspirate the pus from the abscess. However, aspiration was challenging due to the pus's slimy nature. The skin over the abscess easily ruptured during the needle insertion, allowing for easy observation of the pus inside. Subsequently, the pus was flushed out with physiological saline, and sterile gauze, scissors, and tweezers were used to drain the pus and remove necrotic and dead tissues from the abscess. The wound was flushed with physiological saline multiple times.

After completing the pus drainage and removing necrotic tissues, the wound was treated using Nebacetin, which contains neomycin sulfate as an antifungal and bacitracin as an antibacterial. Following the wound dressing with the topical powder, the veterinarian clipped the hedgehog's curled and overgrown nails. The patient was then discharged from the hospital, and the veterinarian provided instructions to the owner for home treatment.

The home treatment includes cleaning the wound twice a day. Wound flushing was performed using physiological saline, and wound debridement was carried out when necrotic tissues appear. After wound flushing and necrotic tissue debridement, topical powder of Nebacetin was applied to the wound. Additionally, the patient was prescribed Amoxicillin at a dosage of 15 mg/kg orally every 12 hours for seven days. Daily wound cleaning and topical antibiotics were continued for 14 days following the initial hospital visit.

RESULTS AND DISCUSSION

The anamnesis for this current case report involved a pygmy hedgehog patient who visited the Veterinary Teaching Hospital of IPB University on April 10, 2023, with an enlarged mass on the left ventral side of the thorax. Subsequently, a physical examination of the pygmy hedgehog in this report was carried out with minimal restraint using gloves, as hedgehogs are accustomed to and comfortable with human contact (Simone and Hoefer, 2024; Evans and Souza, 2010). Hedgehogs can be restrained once uncurled by grasping the spined skin similarly to holding the scruff of another species. The hedgehog was grasped just behind the ears where the hairy skin and mantle meet (Doss and Carpenter, 2020). Additionally, observation of the hedgehog from a distance in the pet carrier was also performed to conduct a hands-off examination, as this is an essential step to note any apparent abnormalities (Evans and Souza, 2010; Quesenberry *et al*., 2020). The hedgehog patient stood with a plantigrade stance. Plantigrade locomotion means that the animal stands and walks with its toes and metatarsals flat on the floor. As terrestrial animals, hedgehogs should stand in a plantigrade position with their bodies raised off the ground (Evans and Souza, 2010). To prevent the hedgehog from rolling into a ball during a physical examination, it was positioned on a flat surface for several minutes. Due to the owner's agreement, the physical examination was performed without anesthesia.

During a thorough examination, the axial body temperature was 36.5°C, which falls within the normal range for a pygmy hedgehog. A lump was observed in the left part of the chest during dermatological assessment. The veterinarian observed a mass measuring 1.5 cm x 1.5 cm x 0.5 cm, from which slimy matter, considered as pus, was discharged. The veterinarian noticed that the enlarged mass was soft and movable during further palpation. Nodular lesions can result from infection and abscess formation, while nodular or open wound lesions can be indicative of neoplasia (Kandefer *et al*., 2020; Al-Anshori *et al*., 2023). Therefore, the differential diagnosis was a tumor lesion with a purulent, necrotic center, which could be misdiagnosed as a primary abscess (Szabo, 2021). Skin conditions are commonly reported health issues in African pygmy hedgehogs kept as pets (Keeble and Koterwas, 2020). The mucous membrane of the oral cavity was pink, and no abnormal features were observed. Overgrown nails were noted during the close inspection of the feet and limbs.

Fine needle aspiration, followed by cytology or biopsy and histopathology, combined with culture for infectious agents, is necessary for a specific diagnosis. However, due to budget limitations, these procedures were not performed in this case report. Additionally, wound treatment was administered in this case. Treating wounds in hedgehogs is essential for subcutaneous abscesses (Heatley, 2009). This case report involved the excision of an abscess in a pygmy hedgehog. The wound-cleaning procedure in this hedgehog case follows principles used in companion mammals (Hernandez, 2004). Small mammals, including pygmy hedgehogs, frequently undergo integumentary surgeries such as trauma, epithelial or subcutaneous mass removal, and surgical debridement of abscesses (Miwa and Sladky, 2016). Circumstances that might lead to wound development in hedgehogs include trauma, dermatophyte infection, domestic animal attacks, overgrown nails, dermatitis due to external parasites, complex abscesses, contraction of limbs with mat fibers, and neoplasia.

Wound Debridement, Cleansing, and Decontamination

Excision of abscesses is a standard integumentary surgical technique in small mammals (Miwa and Sladky, 2016). The procedure for cleaning the subcutaneous abscess followed small mammals' surgical principles similar to those used in dogs and cats (Miwa and Sladky, 2016). Treatment for epidermal wounds in hedgehogs might be required due to overgrown nails, abscesses, and other conditions (Heatley, 2009). Injection and splash block of Lidocaine was administered before and during the wound cleaning procedure, as it was highly recommended without interfering with the wound healing process (Graham *et al*., 2021). Pus in small exotic mammals is typically caseous and does not drain properly. In this case report, the pus was caseous and challenging to withdraw using a syringe with a butterfly catheter; therefore, surgery should be used to treat the abscess (McLaughlin and Strunk, 2016). The skin was damaged when the butterfly catheter was inserted into the lump. After removing the damaged skin, visible debris and pus were manually removed. Following the removal of all visible pus and debris, the abscess was flushed with sterile normal saline several times (Graham *et al*., 2021).

In this case, tissue loss was present because the skin's 1.5 cm x 1.5 cm diameter was damaged due to necrosis; thus, the wound was managed as an open wound. Managing abscesses with tissue debridement and flushing can help protect the wound during the healing process (Graham *et al*., 2021). Bandaging is recommended following these processes because it can protect the wound during healing. However, in this case, it was challenging for the owner to perform bandaging during home treatment. As mentioned earlier, the wound was managed as an open one due to skin loss due to necrosis; however, after flushing, the wound was covered using Nebacetin. For infected wounds, such as in this case, recovery by secondary intention, or open wound healing, is the best option (Maguire *et al*., 2021). Topical antimicrobial use in infected wounds has advantages, such as achieving high tissue concentrations of the antimicrobial agent at the location of interest, requiring a minimal amount of antimicrobial, and avoiding the need for parenteral delivery, reducing the possibility of systemic side effects.

Furthermore, topical treatment is simpler to apply and causes the patient less pain and/or stress. However, topical treatment has drawbacks, including the potential to affect the wound healing process, the lack of evidence for the medication's efficacy when applied topically, and the risk of ingestion or skin absorption, both of which could result in side effects (Graham *et al*., 2021). The ideal wound closure would be to suture the wound as soon as possible after cleaning (Hernandez, 2004). In this case, wound closure with suturing cannot be performed because the outer part of the skin of the abscess was already dead. Maximum drainage of purulent discharge and culture issuance of aerobic and anaerobic bacteria are advisable (Szabo, 2021). The goal of drainage and antibiotic remedy is to reduce the size of the abscess to facilitate surgical excision; however, this technique may help with the cure if the abscess is small and responsive (Szabo, 2021).

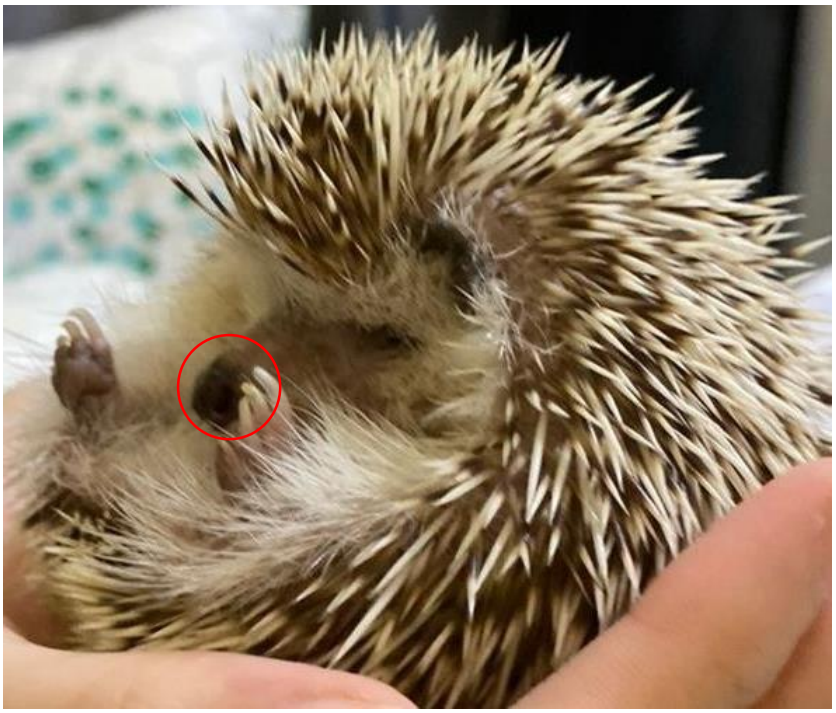

Figure 1. Overgrown nails of the hedgehog hindlimbs.

Figure 2. (A) The mass sized 1.5 x 1.5 x 0.5 cm during physical examination in the hospital before needle insertion showed slimy white matter, (B) after needle insertion showed wounds and damaged skin, as well as overgrown nails of forelimbs. Differential diagnosis: tumor with a purulent, necrotic center. Prognosis: fausta–dubius.

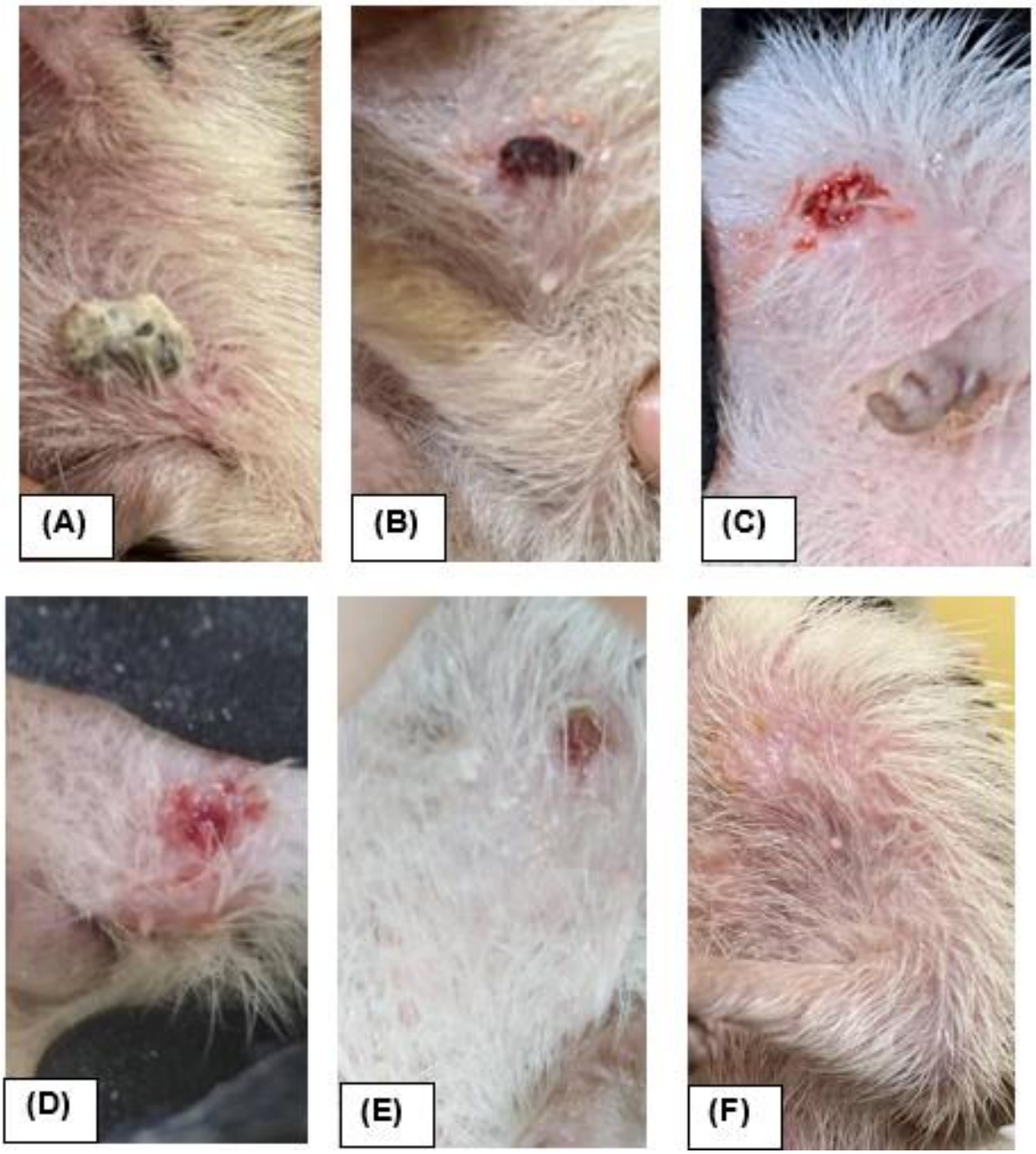

Figure 3. The condition of the wound of the enlarged mass or abscess was (A) 3 days, (B) 4 days, (C) 5 days, (D) 6 days, (E) 7 days, and (F) 14 days after pus drainage and the wound fully recovered.

Abscesses in small mammals, such as hedgehogs, can be caused by several factors, such as poor nutrition, trauma, or bacterial infections. Abscesses are localized collections of pus that form within the body's tissues. They are usually caused by bacterial infections and can occur in any part of the body. Abscesses are superficial masses or lumps, especially in rodent species like rats, guinea pigs, mice, and hedgehogs (Miwa and Sladky, 2016). The cause of the abscess's presence in this patient is unknown. However, trauma in hedgehogs can occur after falls and other wounds (Lennox, 2007). Since the hedgehog was housed alone without cage mates, abscesses did not result from bite wounds from cage mates. The possible cause of the subcutaneous abscess is a wound and infection due to overgrown nails.

Initial wound care begins with preventing further contamination. If a wound cannot be addressed immediately, it should be moistened with physiological saline and covered with sterile

gauze or nonadherent bandaging materials. Any manipulation of the wound from the point of presentation should avoid adding additional debris and microbes to the wound, including wearing sterile gloves whenever handling the wound (Rani *et al*., 2022). Additionally, gloves should be worn to prevent antibiotic-resistant organisms from a hospital setting from colonizing the wound (Hernandez, 2004).

Pygmy hedgehogs frequently develop pyoderma and abscesses (Bexton, 2016). In this case, abscess and pyoderma represent a sporadic case of exudative dermatitis notable on the ventral side of the body. Appropriate treatment should be administered once an abscess is diagnosed in a hedgehog. Pyoderma, caused by bacterial infection, is a common secondary complication in cases of mange and fungal infections (Bexton, 2016). The bacteria identified as causing abscess formation in hedgehogs include *Fusobacterium varium*, *Bacteroides fragilis* (Duangurai *et al*., 2019), *Staphylococcus aureus* including Lancefield Group A Streptococcus, *Pseudomonas sp*., and *Escherichia coli* (Bexton, 2016; Rodenbaugh *et al*., 2020), *Streptococcus pyogenes* (Franklinos *et al*., 2020), and *S. dysgalactiae* (Rodenbaugh *et al*., 2020).

Subjective decisions were made in the case reported here. Amoxicillin was empirically chosen as a broad-spectrum antibiotic (Rodenbaugh *et al*., 2020). Identifying the bacteria type and conducting antibacterial sensitivity testing on the bacteria causing the abscess infection can serve as the basis for determining the appropriate antibiotic for the patient. The treatment protocol should then be adjusted in response to the culture and sensitivity test results (Szabo, 2021). Additionally, cytology of impression smears could be employed to observe the presence of bacterial populations and/or leukocytes (Rodenbaugh *et al*., 2020). However, due to budget constraints and time limitations, these procedures were not performed.

Therefore, the veterinarian prescribed systemic syrup antibiotics as recommended, specifically amoxicillin at a dose of 15 mg/kg twice daily orally for seven days. Amoxicillin is palatable for hedgehogs (Heatley, 2009; Carpenter and Marion, 2013; Hedley, 2020). The prescription of amoxicillin was necessary in this case due to the presence of abscessation and the possibility of secondary infections. Amoxicillin binds to penicillin-binding proteins involved in bacterial cell wall synthesis, reducing the strength and rigidity of the cell wall, and affecting cell division, growth, and septum development. This antimicrobial acts in a time-dependent bactericidal manner (Sucita *et al*., 2019). Amoxicillin is effective against Gram-negative and Gram-positive aerobic organisms, as well as other obligate anaerobic bacterial infections (Hedley, 2020). Starting the hedgehog patient with an abscess on systemic antibiotic therapy immediately aimed to expedite the healing process. Although administering oral medication to hedgehogs can be challenging, the patient cooperated in taking the syrup with a syringe. Alternative methods of administering medication to hedgehogs, such as injecting drugs into mealworms or mixing medications with the hedgehog's favorite food, can also be employed. Some medication odors may trigger behavior.

In addition to oral medication, the treatment involves daily abscess drainage and administration of antibiotics to clear the infection. Elizabeth collars are not a suitable option for hedgehogs, as they enjoy grooming themselves. Topical medications, especially those that hedgehogs find unpleasant or toxic, can be easily removed and unintentionally swallowed or lapped along the dorsal spines (Heatley, 2009; Hernandez, 2004). It is recommended to use topical drugs that wash off after use or can be taken orally. Generally, topical treatments should be kept to a minimum whenever possible, and light coatings of any topical drug are advised (Heatley, 2009; Lesmana *et al*., 2023). However, in this case, the topical application of the antibiotic was not performed due to the wound-cleaning procedure during home treatment. Home treatment of the wound involves daily cleaning using NaCl 0.9% and the subsequent application of topical antimicrobials (Cahya *et al*., 2020).

Hedgehog toenails have a spherical cross shape and a sharp caudal curvature (Heatley, 2009). Routine inspection and trimming of

hedgehog toenails are essential as they can become ingrown or overgrown (Simone and Hoefer, 2004; Tighe and Brown, 2020). The veterinary examination confirmed that the hedgehog's toenails were overgrown, so the veterinarian clipped the nails after cleaning the wound. Regular toenail inspection and clipping are vital to prevent a recurrent abscess since overgrown toenails are a potential cause of abscesses in hedgehogs (Simone and Hoefer, 2004). In this case, nail clipping was performed without anesthesia, with the owner assisting in animal handling while the veterinarian clipped the nails. Hedgehog nail trimming should be done above the pink part of the nail, as cutting too close or touching the pink part may cause bleeding from the hedgehog's nail. The present study reported satisfactory progress with no recurrence of the abscess. The condition of the wound shows improvement after debridement, and fourteen days after treatment, the patient's wound is fully healed (Figure 3). However, it's worth noting that while wound irrigation with topical and systemic antibiotic treatments may clear the abscess, other studies have reported abscess recurrence (Szabo, 2021).

CONCLUSION

This case study reported the presence of an abscess in the pigmy hedgehog and overgrown nails in four of the limbs right and left of the hind and forelimbs. Under local anesthesia, pus drainage was carried out and the debridement was performed using a sterile needle and tweezers. Pus debridement was performed with flushing several times with sterile normal saline and lastly, the wound was treated with topical antibiotics. Home treatment with antibiotics for 7 days and wound treatment for 14 days was performed and the patient responded effectively. The hedgehog fully recovered from the subcutaneous abscess 14 days after the first hospital visit. No reoccurrence was informed in the subsequent month after resolution.

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AUTHORS' CONTRIBUTIONS

NGB: Conceptualization and drafted the manuscript. NGB, NTQW, and PRR: Treated the animal. AP: Validation, supervision, and formal analysis. All authors have read, reviewed, and approved the final manuscript.

COMPETING INTERESTS

The authors declare that they have no competing interests.

REFERENCES

Al-Anshori, A. A., Putri, A. N., Ismi, A. N., Suhud, M. K., Plumeriastuti, H., & Maslachah, L. (2023). Efficacy of Transdermal Delivery Nano Ethosomal Gel from Ashitaba Leaves on In-vivo Burn Wound Healing in Albino Rats. *Jurnal Medik Veteriner*, 6(2), 145–154.

Bexton, S. (2016). Hedgehogs. In BSAVA manual of wildlife casualties. BSAVA Library. pp: 117–136.

Cahya, R. W., Yudaniayanti, I. S., Wibawati, P. A., Yunita, M. N., Triakoso, N., & Saputro, A. L. (2020). The Effect of Sukun Leaf (*Artocarpus altilis*) Extract on Collagen Density of Excision Wound Healing in Albino Rats (*Rattus norvegicus*). *Jurnal Medik Veteriner*, 3(1), 25–30.

Carpenter, J. W., & Marion, C. J. (2013). Exotic animal formulary, 4th ed. Elsevier, St. Louis, Mo. pp: 43.

Doss, G. A., & Carpenter, J. W. (2020). African Pygmy Hedgehogs. In: Ferrets, Rabbits, and Rodents. Elsevier, pp. 401–415.

Duangurai, T., Siengsanan-Lamont, J., Bumrungpun, C., Kaewmongkol, G., Areevijittrakul, L., Sirinarumitr, T., & Kaewmongkol, S. (2019). Identification of uncultured bacteria from abscesses of exotic pet animals using broad-range nested 16S rRNA polymerase chain reaction and Sanger sequencing. *Veterinary World*, 12(10), 1546.

Evans, E. E., & Souza, M. J. (2010). Advanced diagnostic approaches and current management of internal disorders of select species (rodents, sugar gliders, hedgehogs). *Veterinary Clinics: Exotic Animal Practice*, 13(3), 453–469.

Franklinos, L. H., Efstratiou, A., Macgregor, S. K., John, S. K., Hopkins, T., Cunningham, A. A., & Lawson, B. (2015). *Streptococcus pyogenes* infection in a free-living European hedgehog (*Erinaceus europaeus*). *EcoHealth*, 12, 689–692.

Graham, J. E., Doss, G. A., & Beaufrère, H. (2021). Exotic Animal Emergency and Critical Care Medicine. John Wiley & Sons.

Heatley, J. J. (2009). Hedgehogs. In Manual of exotic pet practice. WB Saunders. pp: 433–455.

Hedley, J. (2014). African pygmy hedgehogs: general care and health concerns. *Companion Animal*, 19(1), 40–44.

Hedley, J. (2020). BSAVA Small Animal Formulary Part B: Exotic Pets. British Small Animal Veterinary Association.

Hernandez-Divers, S. M. (2004). Principles of wound management of small mammals: hedgehogs, prairie dogs, and sugar gliders. *Veterinary Clinics: Exotic Animal Practice*, 7(1), 1–18.

Kandefer-Gola, M., Ciaputa, R., Sulima, K., Miszczak, M., Lachowska, S., & Nowak, M. (2020). Metastatic mast cell tumour in African hedgehog: A case report. *Veterinární Medicína*, 65(8), 371–376.

Keeble, E., & Koterwas, B. (2020). Selected emerging diseases of pet hedgehogs. *Veterinary Clinics: Exotic Animal Practice*, 23(2), 443–458.

Lee, A. (2021). Managing disease outbreaks in captive herds of exotic companion mammals. *Veterinary Clinics: Exotic Animal Practice*, 24(3), 567–608.

Lennox, A. M. (2007). Emergency and critical care procedures in sugar gliders (*Petaurus breviceps*), African hedgehogs (*Atelerix albiventris*), and prairie dogs (*Cynomys spp*). *Veterinary Clinics of North America: Exotic Animal Practice*, 10(2), 533–555.

Lesmana, M. A., Amri, I. A., Cahyanissa, A. R., Geoputri, K. M., Anisa, A. K., & Hardian, A. B. (2023). Efficacy of Oregano Extract Ointment on Fibroblast Cells and Epidermis in Albino Rats with Excisional Wound Model. *Jurnal Medik Veteriner*, 6(2), 262–270.

Maguire, R., Ahmad A. A., & Zanten, T. C. (2021). Hedgehogs. In: Graham JE, Doss GA, Beaufrère H (eds) Exotic Animal Emergency and Critical Care Medicine, 1st ed. Wiley, pp: 372–407.

McLaughlin, A., & Strunk, A. (2016). Common emergencies in small rodents, hedgehogs, and sugar gliders. *Veterinary Clinics: Exotic Animal Practice*, 19(2), 465–499.

Miwa, Y., & Sladky, K. K. (2016). Small Mammals. *Veterinary Clinics of North America: Exotic Animal Practice*, 19, 205–244.

Prastika, D. D., Setiawan, B., Saputro, A. L., Yudaniayanti, I. S., Wibawati, P. A., & Fikri, F. (2020). Effect of Shrimp Chitosan Topically on Collagen Density as Excision Wound Healing Parameter in Albino Rats. *Jurnal Medik Veteriner*, 3(1), 101–107.

Quesenberry, K., Mans, C., Orcutt, C., & Carpenter, J. W. (2020). Ferrets, Rabbits, and Rodents: Clinical Medicine and Surgery, 4th ed. Elsevier, Inc, Philadelphia

Ramadita, F. R., & Paramita, I. M. (2019). Heat stroke pada landak mini Afrika (*Atelerix albiventris*). *ARSHI Veterinary Letters*, 3(2), 29–30.

Rani, C. A. M., Safira, A., Suryadiningrat, M., Fikri, F., Wardhana, D. K., & Purnama, M. T. E. (2022). Characterization of Tilapia collagen-loaded chitosan nanofibers synthesized by electrospinning method for wound dressing. *In IOP Conference Series: Earth and Environmental Science*, 1036(1), 012034.

Rodenbaugh, C., Ramachandran, A., & Brandão, J. (2020). Lancefield group a Streptococcus-associated dermatitis in an African pygmy hedgehog (*Atelerix albiventris*). *Journal of Exotic Pet Medicine*, 33, 27–30.

Simone-Freilicher, E. A., & Hoefer, H. L. (2004). Hedgehog care and husbandry. *Veterinary Clinics: Exotic Animal Practice*, 7(2), 257–267.

Sucita, R. E., Hamid, I. S., Fikri, F., & Purnama, M. T. E. (2019). Secang Wood Ethanol Extract (*Caesalpinia sappan L.*) Topically Effective on Collagen Density During Wound Healing in Albino Rats. *Jurnal Medik Veteriner*, 2(2), 119–126.

Szabo, Z. (2021). Soft Tissue Surgery: Rodents. In: Ferrets, Rabbits, and Rodents. Elsevier, pp: 467–482.

Tighe, M. M., & Brown, M. (2019). Mosby's Comprehensive Review for Veterinary Technicians E-Book. pp: 34.

Wissink, A. N. (2020). African Pygmy Hedgehogs. In: Kubiak M (ed) Handbook of Exotic Pet Medicine, 1st ed. Wiley, pp: 13–26.

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