If the Shoe Fits...An in-depth look at a common zebra's hoof injury repaired via corrective shoeing

Meaghan E. McCarthy, Animal Keeper, Disney's Animal Kingdom
Lake Buena Vista, Florida
Meaghan.E.McCarthy@disney.com

Melaina G. Wallace, Animal Keeper, Disney's Animal Kingdom
Lake Buena Vista, Florida
Melaina.G.Wallace@disney.com

Introduction

In March of 2013 Disney's Animal Kingdom (DAK) was home to 0.1 common zebra (*Equus burchelli*) "Mama". Mama sustained an injury shortly after recovering from an immobilization, which caused her right rear hoof to fold forward. Knuckling over on to the coronary band caused significant damage to the tendons and ligaments in the leg. Keepers, managers, veterinarians, and specialists collaborated to formulate a treatment and husbandry plan for Mama. Over the next six months, she was immobilized seven times, was under the care of a farrier who created specialized shoes for her, and underwent multiple radiographs, ultrasounds, shockwave therapy, footbaths and physical therapy. While the treatment and husbandry plans were extensive, Mama was able to recover to a nearly "normal" gait. This allowed her to be relocated to a new facility in northern Florida with her herd mates in March of 2014. Throughout this paper we will detail the specialized husbandry provided by keeper staff, the custom shoes created for her and the excellent veterinary care she received.

History

Mama was a 12-year-old mare at the time of the injury. She came to DAK in February 2012 along with 0.5 common zebra. They were later housed with an additional 0.6 common zebra. The herd was housed in a 2.5 acre holding pen that was comprised of grass, sand, and trees. It had sloped sides leading into grassy moats. Small holding stalls, 900sqft, were used for feeding, separating, and medical procedures. These stalls consisted of chain link walls, soil cement flooring, and a tarp structure covering approximately 1/3 of the stall.

Mama was neither the most dominant nor the most subordinate zebra in the social hierarchy of the herd and appeared to be pair bonded with a 3-year-old mare, "Tiny". During the six months Mama was under specialized care, she and Tiny were separated from the herd. They were held in the holding stalls described above and in two stalls that consisted of wooden walls and soil cement flooring. A grassy yard was also utilized at times. Separation from the herd enabled keepers to more closely monitor her progress, as well as provide her with a firm substrate to aid her recovery.

Timeline

On March 14, 2013, Mama was chemically immobilized and some light hoof work was performed. Her immobilization and recovery were uneventful. The day following the immobilization, Mama and Tiny were reunited with their herd in the 2.5 acre holding pen. Later that day keepers observed Mama stumble on her right rear hoof and then drag the tip of the hoof on the ground. The next day, her lameness became even more severe. While walking, she allowed her foot to roll over and would take several steps on the coronary band before righting it. This was observed repeatedly throughout the day lasting for five to ten steps per episode. Keepers noted that the episodes appeared exacerbated by soft or sandy substrate. In order to prevent Mama's condition from deteriorating further, animal care staff attempted to shift her into a different holding area that afternoon. However, the stress of trying to separate her from the recently reunited herd in such a large space proved to be too much and the attempts were unsuccessful.

The following morning while shifting for grain, Mama and Tiny were separated from the herd and housed in the holding stalls described above. DAK veterinary staff visually examined her and recommended housing her on a flat surface until further notice. Mama and Tiny were transferred from the temporary holding stall to a barn with soil cement and grassy yard options. A day later, they were given access to the grassy yard, hoping it would be a better surface for her injury. However, Mama's right rear hoof caught on the grass and uneven surface, causing her hoof to knuckle under several times. She was returned to the soil cement yards after approximately two hours of no improvement. Management decided to house her in a single 820sqft yard to restrict her activity. Mama was then prescribed her first round of oral pain medication. She

remained on either Banamine® or Phenylbutazone paste, both non-steroidal anti-inflammatory drugs, for the entirety of her healing process in an effort to reduce inflammation and provide pain relief.

Within five days of starting the medication and being housed on a hard surface, Mama's gait had improved. Her right rear hoof was knuckling under much less frequently, but was only showing a slight limp. Veterinary staff visually examined her and video documentation was subsequently sent to large animal surgical experts at the University of Florida for consultation. It was determined that Mama had most likely sustained nerve damage that would heal over time and to take a 'wait and watch approach'. The recommendation was to continue housing Mama at the barn and to give her access to a second yard, thus doubling her housing space, provided her gait did not worsen. After a week of increased space, Mama's gait had continued to improve and veterinary and animal care staff were comfortable introducing her to the grassy yard to evaluate her ability to ambulate on an uneven surface. Mama and Tiny were then allowed access to the grassy yard. While walking, Mama was observed to shuffle her right rear leg and knuckle under on to the fetlock throughout the day. As a result, the affected fetlock became inflamed and the two were shifted back to the harder surface. Two days later, chips and cracks on the lateral side of the right rear hoof were noted, and inflammation of the coronary band was evident. There were also a few scrapes present on the hock.

After one week with no improvement, Mama was immobilized for a physical examination and radiographs of her right rear leg. A hoof wall abscess was discovered below the coronary band on the lateral side of the hoof. The abscess was addressed by a zoological manager trained in hoof work and antibiotics were administered. Veterinary staff recommended treating the abscess with a footbath twice a day. Once Mama had recovered from the immobilization, she and Tiny were given access to a hallway that ran along their yards in order to desensitize them to the hallway and initiate footbath training. Four days later, Mama was immobilized again for additional hoof work, however this time by a farrier. A custom shoe was fashioned for her right rear hoof and applied with a strong epoxy. This shoe was designed to remove pressure from the abscessed area and distribute Mama's weight evenly throughout the foot (See Figure 1). Synthetic polyurethane shoes were applied to the other three hooves for protection from the hard surface (See Figure 2). The following day, Mama started a 20-day footbath regimen with a diluted Nolvasan® solution and she entered the footbath twice per day (See Figure 3).

On May 11, 2013, about two months after the initial injury, Mama was immobilized again. This procedure included the farrier and DAK veterinarians. An ultrasound and additional radiographs of the injured hoof indicated excess fluid around the tendons between the fetlock and coronary band. The footbath was no longer deemed necessary, but due to the fluid in the joint, hydrotherapy was recommended. The farrier removed all four shoes and replaced them with basic polyurethane shoes. Following the immobilization, keeper staff began to desensitize Mama to a hose for hydrotherapy. The veterinarian recommended using a hose to spray down Mama's hoof twice daily for about 10 minutes per session. Mama was fed moistened beet pulp out of a bowl while keepers ran a hose onto the ground that drained onto her feet. This process was relatively successful in that she became desensitized to the running water. The hydrotherapy overall was never able to be fully implemented, as keepers were not able to apply a pressurized stream of water onto the affected area. Mama and Tiny were then given access to the grassy yard to test Mama's gait on uneven surfaces and allow their hooves and joints reprieve from the hard surface. This time Mama was able to navigate the softer surface without incident.

Figure 1. Customized pressure relieving shoe adhered to Mama's foot with epoxy. This photo was taken in a backstage area.

Figure 2. Synthetic polyurethane shoes for hoof protection. This photo was taken in a backstage area.

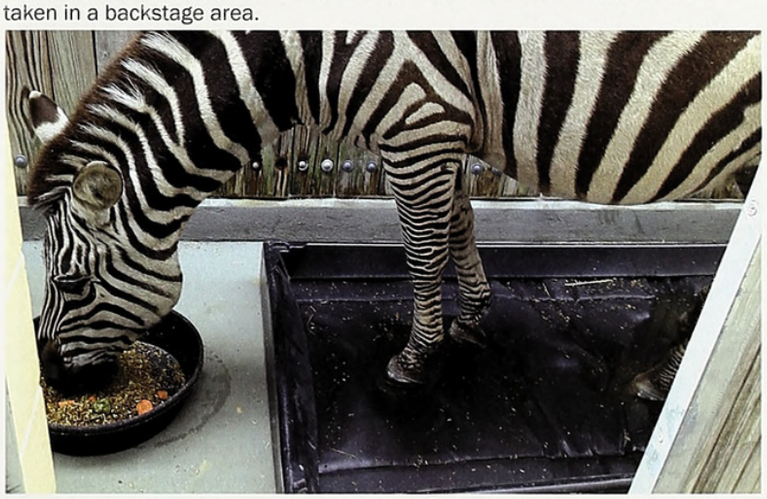

Figure 3. Mama standing in footbath. This photo was taken in a backstage area.

Figure 4. Mama and Tiny in the 2.5 acre holding pen prior to joining their conspecifics. This photo was taken in a backstage area.

Within twenty days of the May 11 immobilization, keepers noted a strong odor emanating from Mama. She was immobilized on June 5, by DAK veterinarians and University of Florida veterinarians. The source of the odor was never identified, but veterinary collaboration determined ligaments on the outer side of the fetlock and those connecting the fetlock to the pastern were enlarged to 2.5 times beyond what is normal. At diagnosis, hyaluronic acid and steroids were injected into the tendon and fetlock areas to reduce inflammation and lubricate the joint. Exercise therapy was also recommended for 10-20 minutes twice daily.

On June 9, Mama and Tiny started exercise therapy. Keepers began with A to B training by calling Mama to walk in an L pattern from one end of the grassy yard to a door at the bottom of a soil cement yard. She was rewarded with a mixture of beet pulp and sweet feed. Mama did not consistently participate in the training, but she still exercised by walking around the two yards. The initial session lasted 15 minutes, and Mama walked approximately half of the time. Tiny was allowed access, but decided not to participate in the training session. Two days later, management allowed Mama to have a larger area for exercise. Keepers encouraged Mama to walk into a wide, dirt corridor by placing bowls containing a few bites of beet pulp and sweet feed in several sequential locations. The corridor was approximately 213 feet in length and 11 feet wide. Tiny was also allowed access since Mama was unwilling to shift alone. This was done daily with varying success due to many distractions and spooking occurrences. Over the course of a week, Mama and Tiny became accustomed to the training and would venture down the corridor calmly, spending approximately 30 minutes exercising daily.

Exercise therapy was a learning process for the zebra as well as the keepers, but in the end the obstacles were overcome and Mama's therapy was successful.

At the end of June 2013, Mama was immobilized for additional hoof work. The farrier reported the previous abscess site was healed, but the hoof would take 10-12 weeks to re-grow completely. The tendons in Mama's right rear leg were now in need of attention. He constructed a wedge-like shoe that would encourage the muscles and tendons along the anterior and posterior aspects of the canon to stretch and lengthen. A shoe was also applied to the left rear hoof to provide balance when walking and standing. The existing exercise program of 30 minutes a day was continued.

At the beginning of August 2013, Mama was immobilized for a physical examination and hoof work. Basic polyurethane shoes were applied to all four feet by the farrier. The ligaments in the right rear leg were palpated and evaluated via ultrasound by DAK veterinarians as well as an equine lameness and imaging specialist from the University of Florida. Additionally, shockwave therapy was administered to the area. In horses, shockwave therapy is used for the treatment of musculoskeletal soft tissue pain and disorders. Sessions provide relief of acute and chronic pain. Equine shockwave therapy also restores mobility and promotes faster healing by stimulating bone growth, tissue regeneration and the release of endorphins.[1] The veterinary team gave approval for a larger exercise space. After being housed at the barn on soil cement with a sod yard, Mama and Tiny were introduced to a large, gradually sloped pen at the end of the corridor, known as the catch pen. The pen had an average gradient of approximately 8% (or 4 degrees.). Mama appeared to have difficulty navigating this incline and began favoring the left rear leg. Despite pain medication, Mama continued to struggle walking up the hill, but did not while walking on flat surfaces. Two weeks after being introduced to the catch pen, Mama was still showing effort while walking, but had improved. Mama did not return to her original gait, but had reached a new "normal"gait. She received her last dose of pain medication on August 20, 2013 five months after the initial medication course was implemented. Three weeks later, keepers found the remnants of Mama's polyurethane shoes in the catch pen. On September 28, Mama was immobilized a seventh time. An ultrasound was performed and the right rear coronary band appeared healed. The farrier was satisfied with the state of the hooves and Mama was fully medically resolved just over six months after the initial injury. The farrier's examination, as well as ultrasound imaging reported that Mama would still have some swelling in her ligaments as well as scar tissue. Her right rear leg would also suffer from 'long term fetlock contracture,' or permanent shortening of the muscles and the joint.

Mama and Tiny remained in their catch pen for an additional four weeks to allow the tendons and ligaments in Mama's leg to strengthen further. Mama continued to walk with a new "normal" gait, one in which she did not plant the bulb of the right rear hoof as close to the ground as the left rear hoof. On October 29, animal care staff felt Mama had mastered the incline of the catch pen and decided she was ready for the 2.5 acres of sandy, hilly pasture where she had previously lived. Mama and Tiny were moved to this area and housed alone for three weeks prior to reintroductions to the herd (See Figure 4). Seven months after their separation, Mama and Tiny were reunited with two of their herd mates. The zebra approached and greeted one another with a minimal amount of kicking and running. Mama's injury did not appear to recur or hinder her in the introduction to the pen or to the other zebra. Four months later, the four animals were loaded into a trailer and transported to a private facility in northern Florida. Mama and her herd mates are currently part of a larger herd and are housed on many acres of grassy pasture. Animal care staff there has reported that she is doing well and her hoof issues have not recurred.

Challenges

Throughout the course of Mama's treatment, keepers were faced with medical, facility and husbandry challenges. Hydrotherapy was an ineffective treatment option for Mama. She would allow the water to spray up on to her feet from the hard surface she was standing on, but would not allow a pressurized stream of water to be applied to her hoof. The goal of hydrotherapy was to reduce inflammation via concentrated water application. Since this was never achieved, hydrotherapy was unsuccessful.

When Mama began exercise therapy in the corridor, the team was faced with several husbandry challenges. The corridor leads to large pens that house multiple different species. The animals housed in these pens, Grevy's zebra in particular, became a distraction to Mama and Tiny as they then shared a fenceline. Keepers would feed the Grevy's away from the shared fenceline in order to encourage them away from this space. The vocalizations from the wattled cranes in the pens initially spooked them, but the zebra quickly became desensitized. The corridor was not covered and therefore storm clouds, rain, and lightning would also cause issues. This was easily dealt with as keepers could adjust the times in which the animals had access to the corridor. Exercise therapy was a learning process for the zebra as well as the keepers, but in the end the obstacles were overcome and Mama's therapy was successful. The other challenge faced was the wearing down of Mama's hooves

from constant housing on a hard surface. The farrier applied shoes to the uninjured hooves in order to relieve pressure and reduce wearing of the feet. Rubber mats were placed throughout the yards in order to provide stable but softer places to stand and walk.

Conclusions

Although lengthy, Mama's recovery was ultimately successful, much due to the diligent teamwork of the veterinarians, keepers, managers, and farrier. Each was willing to go above and beyond expectations and demonstrated patience and adaptability throughout the entirety of her recovery. Daily observations and communication were critical components of keeping the team focused and moving forward. Keepers recorded her progress in the Daily Report System and kept a separate, husbandry-oriented notebook to aid in determining best practices amongst keeper staff. Disney's Animal Kingdom has abundant resources and professional contacts and in this particular case, veterinary specialists at the University of Florida and a skilled farrier partner were utilized. These networks, however, are not unique to this institution. It is possible for many zoos to collaborate with outside partners in order to provide excellent care for the animals in their collections. Hopefully this paper provides useful information, tools and ideas for navigating through a complex situation such as this, and the potentials and benefits of professional partnerships.

Acknowledgements

We would like to thank Disney's Animal Kingdom veterinarians, especially Dr. Natalie Hall and Dr. Diedre Fontenot who were the point veterinarians on the case, the University of Florida veterinarians that consulted on Mama's case, and the farrier Adam Whitehead. We would also like to thank the West Savannah animal care staff for the excellent husbandry care they provided Mama and for their support while writing this paper. Thank you to Hilarie Weiland for photographically documenting the procedures and contributing photos of Mama's hooves to this paper. Many thanks go to the West Savannah zoological managers: Karen Jasmin, Gary Noble, Jen Windau, Robyn Johnson and Steve Castillo for their support and guidance. And last but not least, we would like to thank Dr. Jill Mellen, Education and Science Director at Disney's Animal Kingdom and her staff for reviewing this paper.

Citations

[1] Extracorporeal Shock Wave Therapy (ESWT) For Horse, *FOCUS-IT Your Specialist for Shockwave Therapy & Innovative Technologies*, http://eswt.net/equine, (June 8, 2015)