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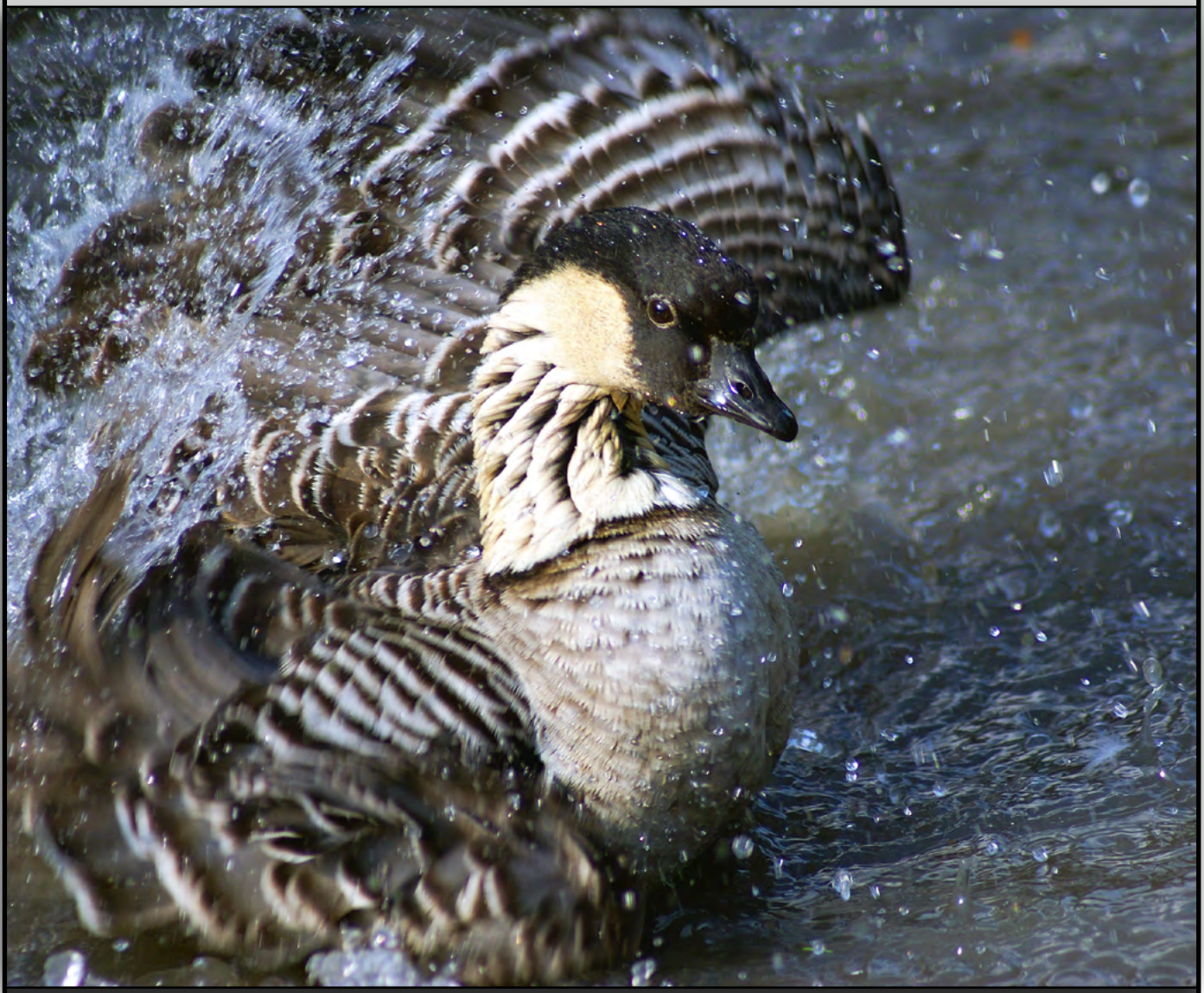

IN THIS ISSUE: FRACTURE REPAIR FOR A HAWAIIAN NENE GOOSE...TRACKING NUTRITION AND GROWTH OF TWO COOPER'S HAWKS FROM EGG TO RELEASE...A LOOK INTO THE GENOTYPE OF THE WHITE NOSE SYNDROME VIRUS...MANAGING DEMANDS UPON A WILDLIFE HOTLINE...THE ROLE OF WILDLIFE REHABILITATION IN KOALA CONSERVATION.

A Novel Approach to Tibiotarsal Fracture Management in the Hawaiian Nene

Ann Goody, Jacob Head, Athena Gianopoulos, Sharon Liu, and Brianna McCoy

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Figure 1. Nene upon intake with a traumatic, compound, transverse fracture of the left tibiotarsus.

ABSTRACT: An endangered Hawaiian nene *(Branta sandvicensis)* with a traumatic, compound, transverse fracture of the left tibiotarsus was admitted for treatment to the Three Ring Ranch, Kailua-Kona Hawai'i, United States. An intramedullary pin was surgically inserted longitudinally through the tibiotarsal bone from hock to knee. External support was provided by a modified Schroeder–Thomas splint (hereafter Schroeder–Thomas–Goody); this allowed wildlife rehabilitators to immediately access the foot for physical therapy and the patient to assume a natural recumbent position. In the past, rehabilitation of birds with similar injuries has been arduous due to the prolonged and intensive physical therapy required to correct contractures that develop from immobilization of the hock and foot. The modifications of the splint enabled physical therapy to begin 72 hr post-operation. Full recovery and release of the nene followed 5 wk later, as opposed to the standard rehabilitative period of 4 to 10 mo for this type of injury.

KEY WORDS: Contractures, fracture repair, Hawaiian goose, intramedullary pin, nene, physical therapy, Schroeder–Thomas splint, tibiotarsal fracture.

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Introduction

Management of fractures in birds has traditionally been challenging due to the high calcium content of bird bones and the resulting brittleness (Bennett *et al.* 1992). Surgical repairs of fractured pelvic limbs commonly involve internal fixation with pins in combination with external support with splints (Harrison and Harrison 1986; Rebecca Duerr, International Bird Rescue, Fairfield, California USA, pers. comm.). External fixation devices used for psittacines and raptors have not been well tolerated by waterfowl and seabirds, who frequently remove the devices themselves, causing extensive damage. Effective as external support during fracture repair, the traditional Schroeder–Thomas (ST) splint immobilizes digits of the bird in a contracted state. In captive psittacines and raptors that typically perch at rest, the degree of restoration of digit function after splint removal, while less than optimal, has been adequate. While the complete restoration of function in the digits is not essential for companion birds, such a recovery is necessary if wild birds are to thrive after release. Achieving this using a traditional ST splint requires a period of immobilization and intensive physical therapy for the digits. As a result, this form of fracture management is not optimal for birds intended to be returned to the wild, especially in birds that depend on a flat-footed gait, such as waterfowl. Traditional ST

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splints are meant to keep an animal upright and enable weight bearing on the lower edge of the splint, which works well for canine, feline, raptors, and psittacines. Furthermore, traditional ST splints limit the ability of waterfowl to rest sternally recumbent and they create pressure on the femoral nerve, damaging nerve function and rendering the affected foot unable to naturally flex or to function normally.

The endangered Hawaiian nene (*Branta sandvicensis*) goose is an example of such a weight-bearing bird. Due to human impact, this species has been pushed to occupy hazardous landscapes such as golf courses, where they are occasionally struck by golf balls. This can result in fractures and, in the past, has required lengthy wildlife rehabilitation times. At Three Ring Ranch (TRR), an exotic animal sanctuary and native wildlife rehabilitation center based in Kona, Hawai'i, the average admission period for this injury was 4–6 mo but has taken as long as 10 mo. With the utilization of the Schroeder–Thomas–Goody (STG) modified splint, rehabilitation time was dramatically reduced due to the lightweight structure and the resulting accessibility of the foot for physical therapy within just days of surgery. The nene, band number 446 by the Hawai'i Department of Land and Natural Resources (HDLNR), was the first case using the modified splint. This nene was released after only 5 wk.

Natural history of the Hawaiian nene goose *(Branta sandvicensis)*

Believed to be a descendant of both the lesser Canada goose (*Branta canadensis parvipes*) and the lesser snow goose (*Chen caerulescens caerulescens*), the nene, state bird of Hawai'i, is an endangered species endemic to the state. Unlike its migratory cousins, nenes never leave the islands and have the smallest range of any goose. With terrestrial habits, the nene possess stouter legs, shorter wings, and partial loss of webbing. These geese are grazers that spend most of their time browsing in grasses, feeding predominantly on plant material, and do not actively seek insects or other invertebrates. The birds undergo a complete molt of their feathers over a period of 6–8 wk which coincide with the rearing of their young. Like many island species, the nene evolved in an environment absent of predators and became the only surviving goose in Hawai'i. Arrival of the first humans pushed the birds to the rockiest, harshest environments in which they were forced to travel great distances to forage and maintain their metabolic intake. This resulted in the sturdy and comparatively robust goose we know today. Dramatic decline in their numbers is attributed to their lack of fear response toward humans and to introduced mammalian predators. Adult nene fell easy prey to humans, while their egg and young populations were decimated by predation. Habitat destruction limited the nene's ability to feed and breed, subsequently limiting their population's ability to recover. Between the 1890s and 1940s, the nene population plunged from 25,000 to 30 individuals. Breeding programs began in the mid-1950s, and the goose was listed as endangered under the Endangered Species Act on 28 December 1973 (16 U.S.C. §1531 et. seq.). Repopulation programs are in place and have had the most success on the mongoose-free islands. Approximately 1,950 nene exist in the wild today with 416 on Maui, 165 on Molokai, 850–900 on Kauai, and 457 on the island of Hawai'i (U.S. Fish and Wildlife Service 2010).

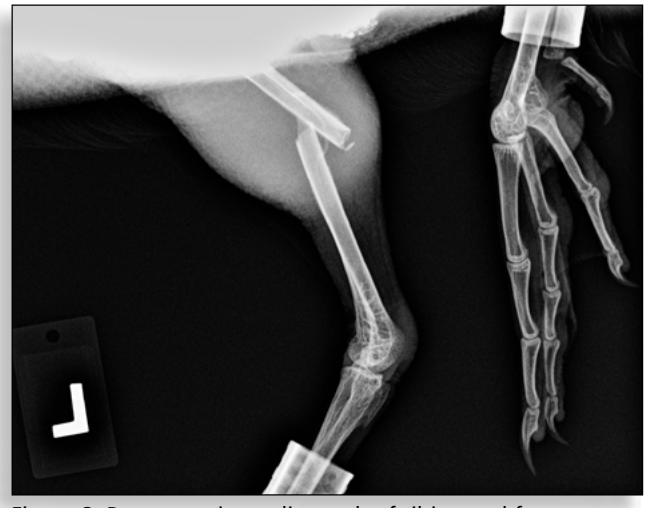

Figure 2. Pre-operative radiograph of tibiotarsal fracture.

Clinical Notes

Intake

The trauma to nene 446 occurred on 27 January 2011 as a result of a golf ball strike. The bird was delivered by the HDLNR for treatment 5 days later. A left leg fracture was suspected due to significant displacement and consequential shortening of the limb. Initial physical exam and radiographs revealed a transverse tibiotarsal fracture of the left leg. The foot had good circulation but was folded, rotated, and developing contractures. The bird was thin but not emaciated. All other findings were normal. When the bird was prepped for surgery and anesthetized, a healing skin break was noted, changing the diagnosis to an open comminuted fracture.

Upon intake (Fig. 1), nene 446's initial radiograph (Fig. 2) showed a significant transverse midshaft tibiotarsal fracture. The bird was kept still in a small ICU crate until surgery. Swelling immobilized the injured limb sufficiently until surgery the next morning. The bird was medicated for pain with an intramuscular (i.m.) injection of buprenorphine 0.006 mg. The patient was a 3-yr-old, otherwise healthy ambulatory bird and was, therefore, a good anesthetic candidate for internal fixation. (Hawaiian nene are all banded by the HDLNR prior to first flight, so we knew not only the hatch year but the geographical location at which the bird was hatched.) We had the availability of an exceptionally trained orthopedic surgeon, Jacob Head, D.V.M., who donated his time and services to operate on nene 446 on 3 February 2011.

Surgery and splinting

The midshaft tibiotarsal fracture was reduced with an open approach to the lateral surface of the fracture site. Closed reduction alone was not enough to adequately reduce the fracture ends due to a large soft-tissue callus already present at the time of surgery. Once

the fracture was reduced, an intramedullary pin was introduced from the distal lateral condyle of the tibiotarsal bone and pushed proximally through the fracture site and ending in the proximal segment. The intramedullary pin was 3/32 in (0.24 cm) in diameter and was placed 4.33 in (11 cm) into the tibiotarsus, continuing 3.92 in (9.90 cm) proximal to the fracture. The distal end of the pin was bent to prevent displacement. The patient was induced using isoflurane (isofluorane USP; Baxter, Deerfield, Illinois, USA) delivered through a mask at a rate of 2–3 L/min at an initial 3.5 percent and a maintenance rate of 2.5–3.0 percent. A brief increase to 3.5 was required during alignment of the fracture ends.

Figure 3. The ST-modified (Schroeder–Thomas–Goody; STG) splint frame.

We determined that the intramedullary pin would allow adequate bending of distal joints and provide for stability of the fracture ends. The incision was closed with monofilament absorbable suture. The bird was medicated for pain with an injection of buprenorphine 0.006 mg i.m. at the time of surgery and again 12 hr postoperatively. Additional pain medication was provided once daily for 3 days.

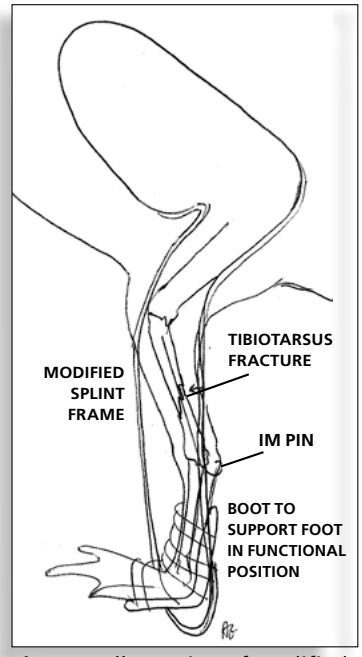

ILLUSTRATION: ANN GOODY

Figure 5. Illustration of modified splint with relationship to leg and body of nene.

The STG modified splint was applied while the patient was under anesthesia to provide external support to the leg and foot. Surgery lasted for 2 hr, significantly longer than the anticipated time of half an hour for similar procedures. The extended surgery time was due to severe edema, fracture displacement, and contracture complications exacerbated by the prolonged period between the time of injury and the time of admittance for treatment (verified to be 5 days based on eyewitness report of initial injury).

The STG splint provided two novel features that played a crucial role in accelerating the rehabilitation of the patient. First, the traditional ST splint was modified from having a fully enclosed ring at the pelvic end to having a semicircle that supported the lateral lower abdomen (Figs. 3, 4). This modification allowed for full pivoting of the hip while providing rotational stability of the fracture, and it also permitted immediate weight-bearing by the bird. With the reduction of splint material at the pelvic end, the STG splint also accommodated the nene's natural tendency to rest sternally recumbent; a traditional ST splint would have interfered with a nene's ability to rest naturally and the injured limb would be forced into a tripod angle when resting in a recumbent position. The splint was well tolerated and the patient was, overall, more comfortable during recovery when compared to prior similar cases.

Second, although the base of the bird's foot was enclosed by the splint frame and the hock of the bird secured to the splint by bandage tape, the foot itself remained exposed (see illustration in Fig. 5). This modification enabled access to the foot, allowing physical therapy to begin at 72 hr without removal of the splint. After application of the modified splint, a supportive boot was secured to the foot for 10 days to limit contractures and maintain position of function. The sole and heel of the boot was constructed from a tongue depressor padded with bandage tape. Half of the tongue depressor was pressed flat against the plantar surface of the foot so that the foot was in the full position of function; the second half created the heel of the boot. The L-shaped boot was secured to the foot with bandage tape, leaving access to the distal half of the foot. This boot prevented contractures by flexing the hock and extending the digits, thereby minimizing the duration of physical therapy required.

Figure 4. Post-operative radiograph of STG modified splint and intramedullary pin

Post-operative care

Nene 446 was housed in a 3 × 6 × 6 ft (0.9 × 1.8 × 1.8 m) indoor cage that limited excessive mobility. To further minimize stress and activity, a screen provided a visual barrier. Physical therapy began 72 hr after surgery and consisted of passive range-of-motion of the toes, including flexion and extension. The boot provided pressure to the sole of the foot, which prevented hyperextension of the hock and balling of the foot. Physical therapy occurred initially as sets of five repetitions, five times daily and gradually increased to 20 repetitions, five times daily for the first 10 days. Physical therapy after the boot was removed continued similarly, with the hock being included in the passive range-of-motion and flexion and extension exercises.

The intramedullary pin and the STG modified splint were removed under anesthesia on 1 March 2011. A radiograph taken to assess the fracture site showed a well-formed callus (Fig. 6). Physical assessment of the surrounding soft tissue showed no edema.

To decrease the likelihood of re-injury, housing the patient

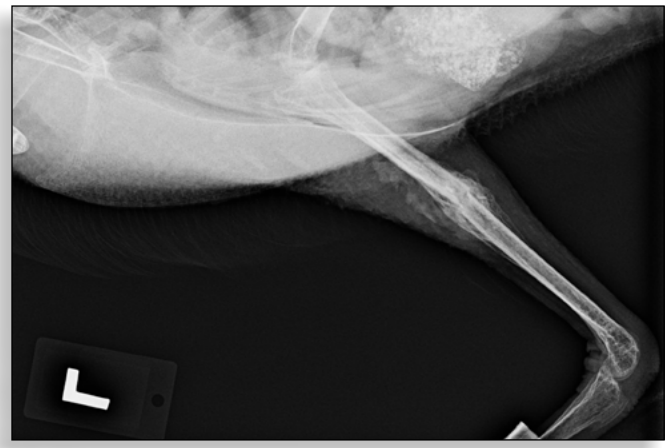

Figure 6. Post-operative radiograph after removal of STG modified splint and intramedullary pin.

in a controlled environment during rehabilitation was necessary. Once awake post-pin removal, the nene was placed in a 35 × 8 × 12 ft (10.6 × 2.4 × 3.6 m) outdoor aviary on grass. At this point, no physical therapy was required as the bird was ambulating gradually back and forth through the entire length of the enclosure to graze. Functionality of the foot increased from 60 to 90 percent in 9 days and was determined by the bird's ability to move back and forth across the pen without subsequent limp. Nene 446 was released on 12 March 2011, only 12 days after the pin was removed, with 100% function of the foot; standard release criteria at TRR is that a bird exceeds 85% restoration of foot function.

Summary

Traditional ST splints have been useful in captive raptors and psittacines. Previous attempts to redesign them for weight-bearing birds such as the wild nene resulted in heavy, cumbersome splints that soiled easily and created panic in the patient. At TRR, we have found through trial and error that, by providing access to the foot for immediate physical therapy post-operatively, we can assure mobility for the foot while keeping the hock immobile. In addition to minimizing foot contractures and the duration of rehabilitation, the modified splint also enabled the bird to rest in its natural, sternally recumbent position which further reduced stress. Because the STG modified splint worked well for nene 446, its application would likely be an ideal alternative to the use of traditional ST splints for wildlife rehabilitators across the board in not only geese but in raptors and psittacines.

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About the Authors

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Ann Goody

Ann Goody, RN, Ph.D., is curator of the ASA- and GFAS-Accredited Three Ring Ranch Exotic Animal Sanctuary (www.threeringranch.org) in Kailua Kona, Hawai'i. She cares for the 150 or so residents of the Sanctuary along with her husband, Norm Goody, M.D. Prior to her curator position she was an emergency room nurse and the administrator of a home health care agency.

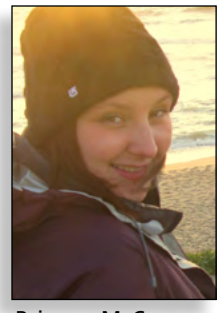
Dr. Jacob Head

Dr. Jacob Head was born and raised in Hawaii. At an early age he was instilled with a sense of stewardship for the land and the animals on it. Raised on a farm in South Kona, he was an active participant in 4H. His family still owns and operates an organic coffee farm that they tend with the help of a flock of white Chinese Geese. Dr. Head spent 18 years of his adult life in Colorado. After he obtained his DVM in 1998, he completed an internship in small animal medicine and surgery in New Mexico. Dr. Head works at the Keauhou Veterinary Hospital, the only AAHA-accredited practice on the Big Island, and is a member of the AVMA, CVMA, HVMA, and the Veterinary Orthopedic Society. Dr. Head, his wife, and three children work and reside with him in Kailua-Kona, Hawaii.

Athena Gianopoulos has a BS from Berkeley and plans on pursuing a degree in veterinary science**.**

Sharon Lin

Sharon Liu graduated from U.C. Berkeley in 2010 with a BA in Integrative Biology and has been working at Pet Emergency Treatment & Specialty Referral Center since. She cooks for Lothlorien Berkeley Student Cooperative, a vegetarian house of 60, and will be attending veterinary school in 2012. She enjoys volunteering at The Marine Mammal Center, serenading, bird-watching, and crocheting critter beanies.



Brianna McCoy

Brianna McCoy, BS, BA graduated from the University of California Berkeley with degrees in Conservation and Resource Studies and Integrative Biology. She currently works for the Wildlife Branch of the California Department of Fish and Game and plans to attend veterinary school to study wildlife medicine.