Clinical Report

A Novel, Nonsurgical Method for the Treatment of Tibiotarsal Rotation in Asian Houbara Bustard *Chlamydotis macqueenii* (Otididae) Chicks

Corinne Stiévenart, DVM, PhD

**Abstract**: Rotational limb deformity due to tibiotarsal rotation can affect captive-bred houbara bustard chicks (*Chlamydotis macqueenii*) from an early age. If not completely corrected, the affected birds cannot be released into the wild nor used in captive-breeding projects. A nonsurgical orthopedic method was developed to correct this deformity before growth is completed. The method consists of hobbling digits III and the distal part of the tarsometatarsus of each leg with a self-adhesive conforming bandage that keeps digits III parallel with enough freedom of movement to allow walking. The tibiotarsal bones are left free. This treatment was successful when it was implemented for 20 days on 10-day-old houbara bustard chicks presenting with 60° to 90° unilateral tibiotarsal rotation. Implementing the same corrective method at an older age was not successful. This cheap, accessible, and noninvasive technique may be applicable to other avian species.

**Key words**: deformity, tibiotarsus, bandage, leg, orthopedics, pediatrics, avian, houbara bustard, *Chlamydotis macqueenii*

**Introduction**

The Asian houbara bustard (*Chlamydotis macqueenii*) is a cursorial, medium-sized game bird of slender appearance, measuring 55–65 cm in length. It inhabits arid ecosystems throughout Asia and the Middle East, from the Caspian Sea and Mongolia to the Nile Valley. In 1986, a captive-breeding program was initiated at the National Wildlife Research Center in Taif, Saudi Arabia, in response to marked population declines in Arabia, with the purpose of reintroducing this species into its former habitat. By 2006, 723 captive-bred houbara bustards had been released into the wild in Saudi Arabia.

Rotational deformities of the long bones of the pelvic limb affect several species of birds, including chickens, turkeys (*Meleagris gallopavo*), guinea fowls (*Numida meleagris*), psittacine birds, ratites, and bustards. The cause of tibiotarsal rotation has not yet been investigated in houbara bustards. In other avian species, tibiotarsal rotation is considered to have a multifactorial etiology. Genetics, nutrition, and excessive growth rates from overfeeding with high-protein diets have been implicated, as well as management factors such as inadequate exercise and dietary deficiencies of calcium, phosphorus, vitamin E, selenium, manganese, zinc, methionine or choline. Trauma has also been implicated through disturbance of the growth plate. This highly metabolic active structure is supplied with nutrients by blood vessels that protrude deeply into it from above and below, and its function is easily disturbed by trauma or other insults. Any disturbance, such as local disruption of blood supply, thus results in a slowing of growth on one side of the plate and will rapidly cause a bend. Further, alteration of the mechanical environment of the growth plate after periosteal insult can also result in long-bone deformities in growing birds. Rackard et al. induced tibiotarsal deviation in growing domestic chicks by making an inverted T-shaped, semi-circumferential periosteal incision 5 mm proximal to the distal growth plate of the tibiotarsus. By uniting the 2 growth plates of a long bone into a competitive
pair attempting to grow apart against the resistance of the periosteal membrane, the periosteum might have a restraining influence on growth plates. Therefore, transverse section of the periosteum may remove such restraint, allowing the growth plates to grow more rapidly. Another possible mechanism suggests that the richly vascular periosteum close to the growth plate may stimulate growth-plate activity after periosteal stripping. Left untreated, the tibiotarsal rotation never improves, resulting in an outward rotation of the foot that may reach 180°. Walking is impossible in severely affected houbara chicks because the feet are pointed in opposite directions.

Until 2002, attempts at correcting this deformity in houbara bustards at the National Wildlife Research Center were unsuccessful. Treating 60° to 90° unilateral tibiotarsal rotation at about 10 days of age by wrapping the tarsometatarsal diaphysis of each leg failed to adequately reposition feet and ankles. Houbara bustard chicks repeatedly fell down after knocking and entangling their ankles and soon, they refused to walk and starvation set in, despite efforts to encourage them to eat, drink, and walk (2 cases). Treating the leg deformity at about 10 days of age by hobbling the diaphysis of the tarsometatarsus combined with a light piece of plastic separating the ankles allowed repositioning of feet and ankles (ie, 0° angular rotation); however, chicks remained immobilized and had not recovered after 3 weeks of treatment (3 cases). For both hobbling methods, discontinuing treatment resulted in an increasing inward rotation of the ankle up to 150° to 170°, and the tibiotarsal rotation disabled the houbara bustard chicks. Intervening after leg growth was completed by using a derotational osteotomy of the tibiotarsus or of the tarsometatarsus combined with a bilateral external skeletal fixation according to Meij was also unsatisfactory. Houbara bustards that had ceased standing on the affected, deformed leg before surgery did not stand on it after surgery (3 cases). Houbara bustards that were still using both legs before surgery could not walk normally after surgery because the limb repositioning was not perfect (3 cases). Consequently, none of the bustards treated surgically could be released into the wild or be used as breeders in captivity.

The purpose of this report is to describe a novel technique of treating tibiotarsal rotation in houbara bustard chicks. The objective was to develop a cheap, accessible, and noninvasive method that produces a successful treatment outcome.

Materials and Methods

Cases of tibiotarsal rotation were identified during the production of large numbers of houbara chicks at the National Wildlife Research Center. Captive-bred houbara bustard eggs were artificially incubated at 37.5°C in a horizontal position, with eggs turned regularly. Houbara chicks were reared separately from adult houbara bustards. During the first 10 days, chicks were housed in small acrylic boxes (77 cm × 52 cm × 30 cm [length × width × height]) on a sandy substrate covered by a shade-cloth net to prevent the chicks from ingesting sand. At 10 days of age, chicks were moved into large indoor acrylic boxes (90 cm × 200 cm × 40 cm [length × width × height]) on a sandy substrate. Chicks were kept indoors during the first 20 days. Ambient temperature was 23°C (73°F), and a heater set at 42°C (107°F) was hung above each rearing box. Chicks were exposed to a photoperiod of 12:12 light:dark, supplied by conventional neon tubes. At 20 days of age, chicks were moved outdoors onto a sandy substrate, with a shelter for the night.

Houbara chick diet consisted of Tenebrio molitor mealworms; poultry meat pellets (crude protein, 23.5%; calcium, 3%; phosphorus, 1.1%); enriched with vitamins B complex, amino acids, and trace elements (Anima-Strath, Bio-Strath AG, Zürich, Switzerland); and fresh alfalfa leaves and dry pellets (crude protein, 22%; calcium, 1.5%; phosphorus, 0.7%) made of cereals and by-products of oleaginous plants. The proportions of each food item consumed were not recorded. Because houbara neonates do not feed independently, they were handled for the first 10 days. Subsequently, they fed by themselves, although they had to be encouraged to start feeding.

Chicks were handled daily during their first 10 days to record body mass and then every third day up to the age of 1 month. Individuals were monitored throughout captivity (ie, until their death or until translocation for release into the wild, which usually occurred at 6–9 months of age). Variations in body mass and in tarsus length in males and females were recorded until growth was completed (Fig 1).

Results

Between 2002 and 2007, 17 cases of unilateral tibiotarsal rotation were diagnosed at the National Wildlife Research Center. Impairment was
expressed as a unilateral leg deformity with the tibiotarsus rotating laterally above the ankle joint, resulting in the simultaneous outward rotation of the foot and inward rotation of the ankle. This deformity affected the right leg of 9 (3 male; 4 female; 2 unknown sex) chicks and the left leg of 8 (4 male; 4 female) chicks. The angular amplitude of the tibiotarsal rotation was measured in each bird (Fig 2). At hatching, no limb deformities were visible in any chicks. In affected chicks, a 5° outward foot rotation affecting the leg was detected at about 5 days of age and worsened rapidly, resulting in a 60° to 90° inward ankle rotation by 10 days of age.

In 15 cases, attempts at treating the leg deformity were implemented at an early age (ie. by 10 days of age), when the outward rotation of the foot reached 60° to 90° (Fig 2C and D). Two cases were treated at 15 days of age, when the outward rotation of the left foot reached 100° to 110°. In both groups, the treatment method consisted of hobbling digits III and the distal part of the tarsometatarsus of each leg with a self-adhesive conforming bandage (Co-Plus, Smith & Nephew, London, United Kingdom), that kept digits III parallel with enough freedom of movement to allow the chick to walk (Fig 3). The tibiotarsal bones were left free. Hobbling digits III and the distal tarsometatarsus of each leg allowed immediate repositioning of feet and ankles (ie, 0° angular rotation). Typically, the first days of treatment were stressful: chicks became inactive, remained prone, did not vocalize, and did not interact with other chicks or their keepers. However, adequate stimulation ensured feeding, drinking, and walking.

Treatment at 10 days of age

Chicks treated beginning at 10 days of age (n = 15) started walking spontaneously from the third day of treatment, and the hindrance caused by hobbling decreased daily. After 10 days of treatment, the outward drift of the foot and the inward drift of the ankle were corrected to near normal position (ie, the angular rotation of the affected leg was about 5° without hobbling). Hobbling was maintained until repositioning of
the leg was stable at about 1 month of age. All houbara chicks treated from the age of 10 days recovered and continued growing without any visible limb deformity. Long-term monitoring indicated recovery was complete.

**Treatment at 15 days of age**

Chicks treated beginning at 15 days of age (n = 2) started walking spontaneously from the sixth day of treatment. After 20 days of treatment, the feet and legs were parallel to each other but were no longer aligned to the body axis: the left leg displayed a 45° outward rotation and the right leg a 45° inward rotation because of concomitant rotation of the right tibiotarsus (Fig 2F). Birds were able to walk but not in line with the axis of the body. The treatment was discontinued in both chicks. Within 1 month, the left leg, which was initially treated for tibiotarsal rotation, had further rotated to about 170°, whereas the right leg, which was initially healthy, returned to a near-normal position (i.e., 5° angular rotation). The rotation of the tibiotarsus of the left leg completely disabled chicks.

**Discussion**

When treated at about 10 days of age, the prognosis of tibiotarsal rotation was excellent in the houbara bustard chicks that received the corrective orthopedic treatment involving hobbling digits III and the distal tarsometatarsi. Hobbling digit III counteracts the developing tibiotarsal rotation, whereas incorporating the distal tarsometatarsus in the wrapping maintains the toe-hobbling on the toes while still allowing houbara chicks to walk. However, adequate stimulation to ensure feeding, drinking, and walking was essential to success.

Treating tibiotarsal rotation in nondomesticated growing birds is challenging because they are prone to treatment-related stress. Any disturbance or painful treatment can result in severe
prostration and subsequent starvation. Moreover, any defensive reaction of the chicks against hobbling can result in additional leg trauma, including fracture, luxation, or strain.

Houbara bustards are nidifugous cursorial birds. Rotational deformity or dysfunction of the leg is presumed to be detrimental to houbara bustard survival because it reduces the ability of birds to find food in their natural environment, to escape from predators, and to display breeding behavior. To reduce the period of disability and to restore proper leg development and function before leg growth is complete, corrective treatment of the tibiotarsal rotation was implemented as early as possible (i.e., at about 10 days of age) when chicks were able to feed independently. At that time, chick leg length was about 40% and 45% of adult leg length in male and female houbara chicks, respectively (Fig 1). During the next 20 days (i.e., the duration of the treatment), the houbara chicks gained about 30%–35% of the adult leg length.
In Asian houbara bustards, the ossification of the tibiotalarsus is completed between the ages of 49 and 63 days for the distal tibiotalarsus and between 93 and 113 days for the proximal tibiotalarsus. When hobbled was implemented at about 10 days of age, the tibiotalarsal rotational deformity was completely corrected between 20 and 30 days of age, well before tibial ossification is complete. Long-term monitoring indicated recovery was complete with such an early treatment.

The same treatment, implemented at 15 days of age, when the leg rotational deviation was more than 90°, was not successful. The traction of the deformed leg on the healthy leg through hobbling induced a subsequent deviation of the healthy leg. Both legs became malaligned to the body of the axis, which was not acceptable. Earlier implementation was not preferred because it would affect the behavioral development of the chicks, particularly their ability to feed independently.

Although the cause of tibiotalarsal rotation in captive-bred houbara bustard chicks at the National Wildlife Research Center has not yet been identified, early monitoring of the chicks is crucial in the diagnosis and successful treatment of this condition. Tibiotalarsal rotation affects many other captive-bred avian species, each of which presents its own specific mechanical constraints and body development. This inexpensive, accessible, and noninvasive technique may be of potential use in other avian species, such as gruiform birds.

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References