SHORT COMMUNICATION

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Congenital and Neoplastic Cranial Deformities in Wild Giraffe (*Giraffa* spp.)

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ABSTRACT: Congenital deformities and neoplasia are poorly documented in wildlife, owing to the difficulty of detection in wild populations. Congenital deformities may lead to premature mortality, thus reducing the chances of thorough documentation. Importantly, neoplasia diagnoses depend on either sampling suspicious lesions from living individuals or access to fresh, undisturbed carcasses, which can prove challenging. We describe five cases of suspected congenital cranial deformities (midfacial cleft, wry nose, and brachygnathia inferior) and two possible cases of cranial neoplasia (orbital bone mass and a soft tissue mass) opportunistically observed in wild giraffe (*Giraffa* spp.) across their range in Africa. Although cases are largely limited to subjective description because physical examination is often not possible, it is critical to document such observations to help identify and track potential health concerns in wild giraffe populations.

Key words: Congenital cranial malformation, *Giraffa*, giraffe, neoplasia, wild.

Congenital defects and neoplasia are uncommonly reported in wildlife. In horses and cattle, congenital defects occur in about 1–4% of individuals and usually require surgical intervention for survival (Shaw et al. 2015; Canatan et al. 2020; Niwas et al. 2020; Cunningham and Mead 2022). There are reports of congenital cranial deformities occurring in multiple species of wild ungulates (Wobeser and Runge 1973; Gogan and Jessup 1985; Smits and Bubenik 1990; Hoy et al. 2011; Hata et al. 2020; Cunningham and Mead 2022). In giraffe (*Giraffa* spp.), observations of congenital defects have included two cases of dwarfism (Brown and Wells 2020) and one of severe brachygnathia superior (Lightfoot 1977).

The true prevalence of neoplasia in wildlife is unknown because of understudying and reporting, but neoplasms have been observed in ungulates (Williams et al. 1989; Foreyt et al. 1991; Madsen et al. 2017; Jones et al. 2018; Pesavento et al. 2018). Current knowledge on the occurrence of neoplasia in giraffe is from zoo populations, where it has rarely been reported and has usually involved the reproductive tract (Jones et al. 2018; Doden et al. 2021). The few reported cases associated with the head have included oral and nasal lesions of squamous cell carcinoma, oral lesions of ameloblastic fibroma, a rhabdomyosarcoma of head musculature, and a complex odontoma of the rostral mandible (Bohner et al. 2021; Doden et al. 2021). In wild giraffe, two reported cases of severe multiple papillomatosis associated with papillomavirus in southern giraffe (*Giraffa giraffa*) included involvement of skin of the head and neck (van Dyk et al. 2011). Searches of the *Journal of Wildlife Diseases*, the *Journal of Zoo and Wild Animal Medicine*, and zoo and wildlife academic books, plus wider searches in Google Scholar and ResearchGate failed to find other reports of congenital cranial skeletal abnormalities, cranial neoplasia, or other deformities of the cranium in giraffe.

Here we describe seven cases of cranial abnormalities observed in two species of wild giraffe (northern giraffe *Giraffa camelopardalis* and southern giraffe; Fennessy et al. 2016; Coimbra et al. 2021). The giraffe were either opportunistically encountered during routine population surveys or reported to wildlife authorities. We present them to serve as a basis for comparison for future observations on the occurrence of cranial abnormalities in giraffe.

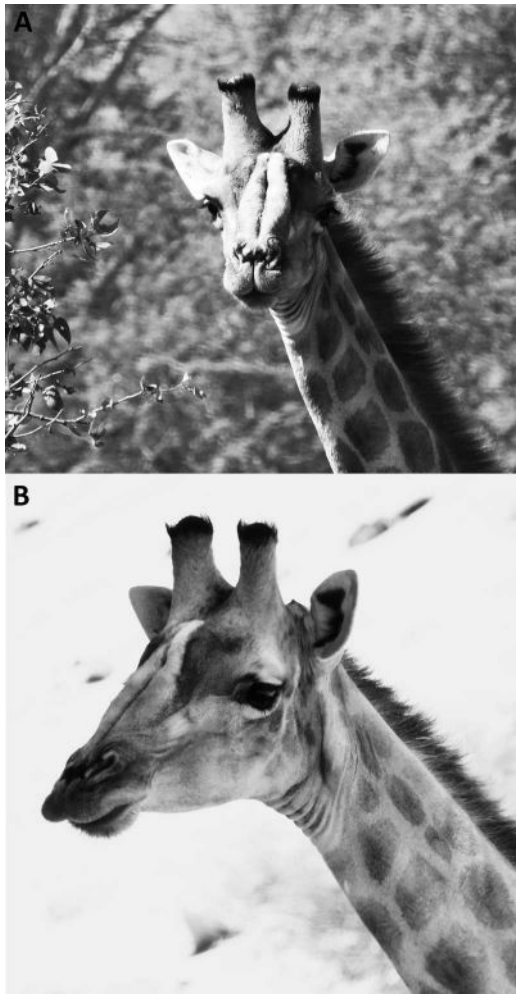

FIGURE 1. Adult male Angolan giraffe (*Giraffa giraffa angolensis*) in northwest Namibia with a midfacial cleft palate. (A) Anterior view of the giraffe's head, with a well-defined groove representing the suspected midfacial cleft noticeable running from the upper lip between the eyes to the mid-upper skull. (B) Lateral view of the head, again with the midfacial cleft apparent by the well-defined groove through the middle of the skull. Photographs courtesy of Giraffe Conservation Foundation.

An adult male Angolan giraffe (*Giraffa giraffa angolensis*) with a midfacial cleft palate was observed in northwest Namibia during a routine population survey conducted by the Giraffe Conservation Foundation (GCF) in 2017 (Fig. 1). This individual had a bifid maxillary lip extending in a well-defined groove, possibly caused by a failure of closure of the nasal, and probably also the frontal, bones of the skull. Cleft palates are categorized as defects of the primary (nares and lips) or the secondary (hard and soft) palate and may occur with additional abnormalities (Shaw et al. 2015). From observational data, the only abnormality occurring in this giraffe is the midfacial cleft palate. This giraffe has been resighted regularly, with the most recent resighting occurring in July 2022, and always in good body condition.

An adult female Angolan giraffe and two adult female South African giraffe (*Giraffa giraffa giraffa*) were observed with suspected campylorrhinus lateralis (wry nose). The adult female Angolan giraffe was sighted during a GCF field survey in the Hobatere Concession, Namibia in 2018 with a moderate lateral rotation of the rostral skull to the right (Fig. 2A). The giraffe was in good body condition and noted to have a dependent calf of normal morphological appearance. This giraffe has not been resighted. One adult female South African giraffe was observed in Kruger National Park, South Africa in 2018 with a severe right-sided lateral rotation of the rostral skull with moderate ventral deviation (Fig. 2B). The giraffe appeared in good body condition with a dependent calf of normal morphological appearance (E. Oberholzer pers. comm.). This female was resighted in October 2022 (Vermeulen 2022). A second adult female South African giraffe was observed in Pilanesberg National Park, South Africa in 2019 with a moderate left-sided lateral rotation of the rostral skull and mild ventral deviation (Fig. 2C). The giraffe has been resighted multiple times, most recently in April 2022, and always in good body condition (J. Smith pers. comm.).

Wry nose is a congenital abnormality characterized by lateral and ventral deviation of the rostral bones of the skull (Sapper et al. 2021; Cunningham and Mead 2022). This condition may negatively affect suckling, mastication, and the upper respiratory airway, with moderate to severe deviations of the rostral skull usually requiring surgical correction or humane euthanasia in domestic species

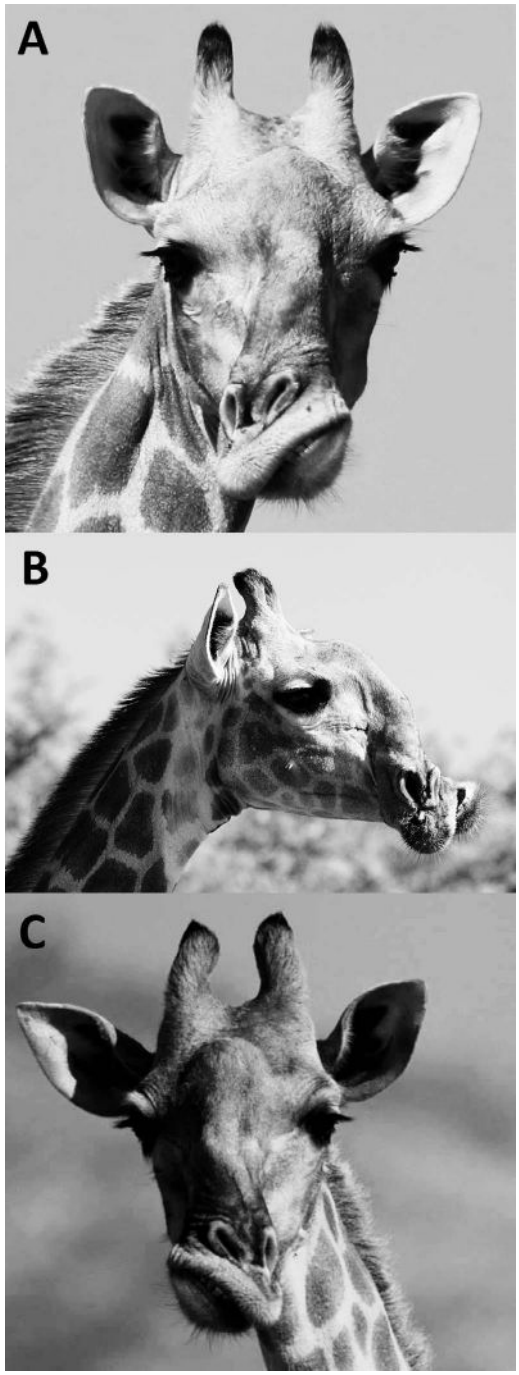

FIGURE 2. (A) Adult female Angolan giraffe (*Giraffa giraffa angolensis*) with moderate wry nose observed in Hobatere Concession, Namibia. (B) Adult female South African giraffe (*Giraffa giraffa giraffa*) with severe wry nose observed near Shingwedzi, Kruger National Park, South Africa. (C) Adult female southern giraffe (*Giraffa giraffa giraffa*) with severe wry nose observed in Pilanesberg National Park, South Africa. Photographs courtesy of Giraffe Conservation Foundation (A), E. Oberholzer (B), and J. Smith (C).

(Sapper et al. 2021; Cunningham and Mead 2022).

A subadult female Nubian giraffe (*Giraffa camelopardalis camelopardalis*) with severe brachygnathia inferior was first observed by GCF during a field survey in Kidepo Valley National Park, Uganda in 2019 (Fig. 3). In domestic species, brachygnathia inferior has been commonly reported and, depending on severity of the condition, may result in malnutrition, growth retardation, dental problems, or even death due to inherent abnormal chewing and food apprehension (Canatan et al. 2020). This female was observed during the GCF survey browsing and drinking despite the severely shortened lower jaw. This giraffe was most recently observed in good body condition in April 2022.

An adult male Nubian giraffe in Lake Nakuru National Park, Kenya was observed in 2019 with a severe facial swelling on the left side of the skull (Fig. 4). This giraffe was immobilized by the Kenya Wildlife Services to administer palliative treatment of injectable oxytetracycline and dexamethasone because of clinical signs of infection. Upon examination and palpation, the swelling was firm and most consistent with a cavitated bony mass disrupting the left ocular orbit, lacrimal, and zygomatic bones, with sections of bone exposed. No samples were obtained during the intervention. Despite the severity of the mass, the giraffe appeared to be in good body condition with no other apparent health concerns. No further information was available. The last case was an adult male Nubian giraffe in Soysambu Conservancy, Kenya in 2019 with a large, multilobular suspected soft tissue mass overlaying the median ossicone (Fig. 5). Veterinary intervention was not performed as he was visibly in good condition with no signs of infection. As a result, no samples were collected for evaluation. This individual moved into neighboring Lake Nakuru National Park, Kenya in February 2022 because of drought conditions and was observed there in good body condition.

Reports of cleft palates occurring in wildlife include observations in many cervid species (Barrett and Chalmers 1975; Gogan and

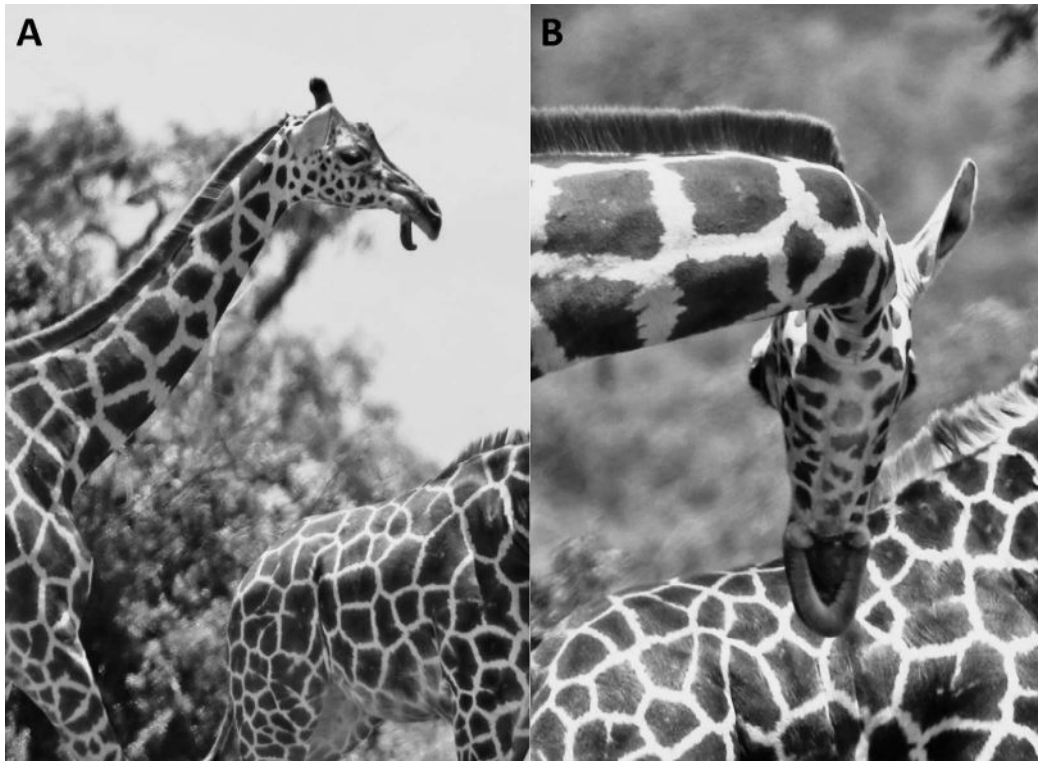

FIGURE 3. Subadult female Nubian giraffe (*Giraffa camelopardalis camelopardalis*) observed with brachygnathia inferior in Kidepo Valley National Park, Uganda. (A) Lateral view of the giraffe's head, with the tongue hanging out where the front part of the lower jaw is missing. (B) The underside of the mandibular jaw revealing the missing rostral part of the mandible and a bifid lower lip. Photographs courtesy of Giraffe Conservation Foundation.

Jessup 1985; Hata et al. 2020). Various factors are suspected as causes for cleft palates, including environmental toxins, infectious agents, toxic plant ingestion by the dam, and nutrient deficiencies (Gogan and Jessup 1985; Shaw et al. 2015; Hata et al. 2020; Cunningham and Mead 2022).

Similarly, wry nose and brachygnathia inferior have also been observed and have mainly been documented in wild cervid and bovid species (Hoy et al. 2011; Chu et al. 2020; Cunningham and Mead 2022). Although the cause of wry nose is unknown, it is unlikely inheritable; in contrast, brachygnathia inferior is hypothesized to be associated with heritable homozygous recessive genes (Mousquer et al. 2019; Canatan et al. 2020; Cunningham and Mead 2022). The female Nubian giraffe in Kidepo Valley National Park, Uganda is part of a small, recently augmented population that underwent a significant bottleneck of three individuals in 1993 (Reynolds 1993) and is now estimated at >70 individuals. Long-term monitoring of this and other giraffe populations combined with genetic studies are important to further assess the risks of congenital deformities in these populations (Brown and Wells 2020).

The presumed congenital abnormalities that were observed in these giraffes cannot be definitively diagnosed as congenital because of lack of observations on the animals as neonates and the inability to perform radiographic or histologic examination; they therefore might be related to other disease processes. We considered them as most likely to be congenital in origin on the basis of the similarities in appearance to referenced congenital abnormalities. It has been hypothesized that most cranial congenital

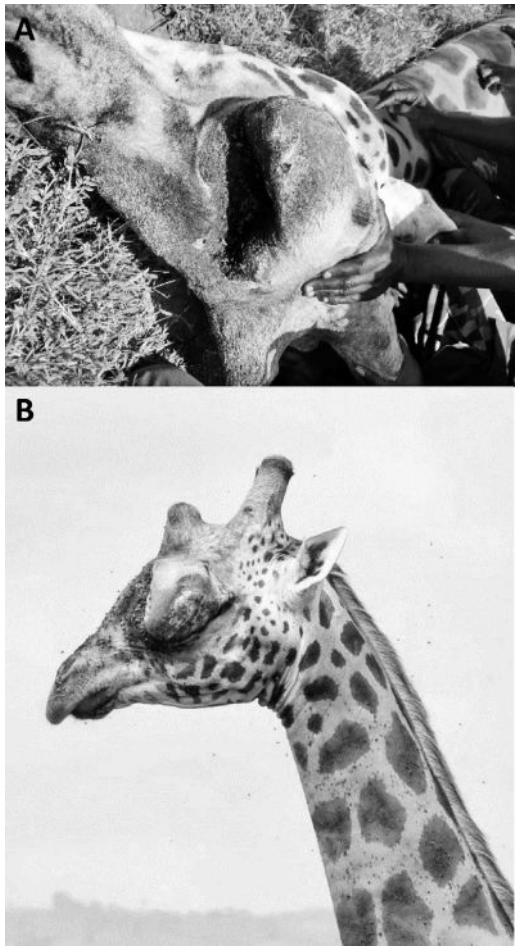

FIGURE 4. Adult male Nubian giraffe (*Giraffa camelopardalis camelopardalis*) with a proliferative bony mass of the left orbit, observed and treated in Lake Nakuru National Park, Kenya. (A) The giraffe in lateral recumbency with the nose oriented in the upper left corner of the photo with an anterior view of the cavitated bony mass where the left eye should be. (B) Lateral photograph of the giraffe standing, showing a side-on view of the mass where the left eye should be. Photographs courtesy of Kenya Wildlife Services.

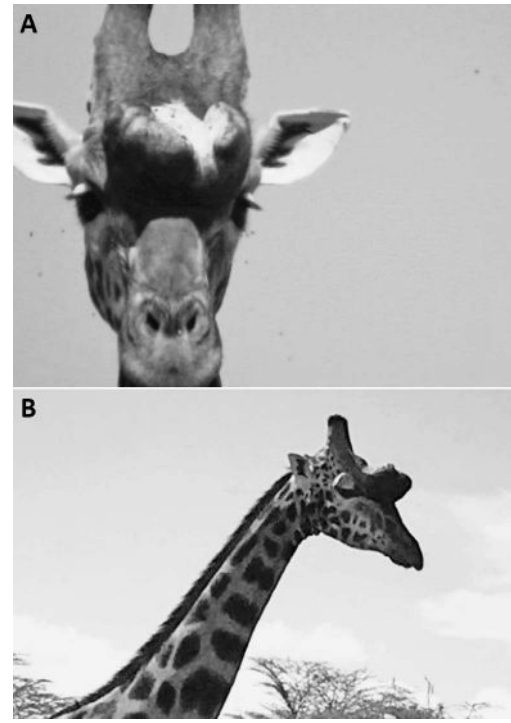

FIGURE 5. Adult male Nubian giraffe (*Giraffa camelopardalis camelopardalis*) with a multilobulated mass associated with the median ossicone observed in Soysambu Conservancy, Kenya. (A) Anterior view of the giraffe's head, with the suspected soft tissue mass overlaying where the median ossicone would be positioned on the forehead. The mass appears to have split and healed at some point. (B) Lateral view of the mass on the forehead. Photographs courtesy of Kenya Wildlife Services.

abnormalities in wildlife probably result in neonatal death associated with impacts on suckling, the respiratory system, maintaining adequate nutrition, and a possibility of concurrent abnormalities in other body systems (Gogan and Jessup 1985; Hata et al. 2020; Cunningham and Mead 2022). Nevertheless, the individuals described above have all survived to adulthood with abnormalities that, on the basis of anatomical severity, would have been considered likely to result in premature death.

The term neoplasia, defined as abnormal and uncontrolled cell growth, was chosen as the most accurate term to describe the abnormalities observed in both Kenyan giraffes (National Cancer Institute 2022). However, in the absence of samples, it was not possible to confirm these as neoplastic; therefore, other disease processes such as infection or trauma should be considered as possible causes of the observed masses. Known causes of neoplasia include pathogen-linked chronic inflammation, low genetic diversity, direct cell transformation, transmissible tumors, toxins, and endocrine disrupting

compounds (Masden et al. 2017; Pesavento et al. 2018). In wild ungulates, reported cases of cranial neoplasia have included osteochondroma, adenocarcinoma, and squamous cell carcinoma (Williams et al. 1989; Foreyt et al. 1991; Slater et al. 2022). Documenting abnormalities in wildlife as indicators for potential trends in ecosystem health is critical. Additionally, animals serve as sentinels for environmental issues that might also affect humans (Hoy et al. 2011). Understanding the potential link of environmental toxins as a cause for neoplasia is of particular importance in Kenya, where an increasing human population and dense human settlements occur in proximity to wildlife. Although the definitive causes of the cases described are unknown, they are important to highlight for tracking potential long-term health trends in all giraffe species.

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