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SHORT NOTE

A preliminar comparative study of cresty neck in the persian onager, przewalski's horse and zebra

Morales-Briceño, A.[1]; Pukazhenthi, B.[2]; Reed, D.[2]; Méndez-Sanchez, A.[1]; Pérez, J.[1]

[1] Department of Anatomy and Comparative Anatomic Pathology, College of Veterinary Medicine. University of Cordoba, Spain.
[2] Center for Species Survival, Smithsonian Conservation Biology Institute, National Zoological Park,1500 Remount Road, Front Royal, VA 22630.

Aditional Keywords

Cresty neck.
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SUMMARY

The aim of this study was to systematic genetic review of the literature on the cresty neck in Spanish Purebred horses. An exhaustive literature review was carried out using databases PubMed (https://www.ncbi.nlm.nih.gov/pubmed), Publons (https://publons.com/), SciELO: Scientific Electronic Library Online (https://scielo.org/) and Google Scholar (https: / /scholar.google.com/). The search was carried out on October 21, 2020. The results of the systematic genetic review of the literature on cresty neck in Spanish Purebred horses identified 633 potential articles in the aforementioned databases, of these a total of 49 articles discuss 8 potentially genetic defects in the Spanish Purebred horse and a total of 15 articles specifically related to cresty neck in Spanish Purebred horses, few disorders were specifically linked to conformation or phenotype. The genetic bases of fat metabolism are associated with cresty neck, in Spanish Purebred horses where obesity and equine metabolic syndrome is a polygenic trait with specific risk alleles of the race. Reports in the literature indicate a high incidence, with a moderate heritability. Morphological and pathological studies describe this defect as a pathological condition given the degree of fat infiltration associated with lipomatosis in the muscles of the dorsal region of the neck.

Palabras Clave

Cresta del Cuello.
Przewalski´s.
Onager.
Cebra.

Estudio comparativo del cuello cresty en el onagro persa, el caballo de Przewalski y la cebra

RESUMEN

El objetivo de este estudio fue describir la cresta del cuello en tres especies de équidos salvajes. Específicamente, examinamos el Przewalski (Equus ferus przewalskii; n = 3 machos maduros), el Onagro Persa (Equus hemionus onager; n = 4 machos) y la cebra (Equus quagga burchellii; n = 4) manejados en cautiverio o semi-cautiverio. Los animales se examinaron durante la evaluación clínica de rutina (en condiciones de anestesia general). Específicamente, se palpó el cuello siguiendo el ligamento nucal y la región muscular. La puntuación de adiposidad solo en cebra se realizó siguiendo el protocolo descrito para equinos. La evaluación del cuello crestado mostró una baja acumulación de grasa, la puntuación predominante fue 1 en la cebra estudiada, sin apariencia visual de cresta, pero leve relleno a la palpación, este nivel corresponde a la condición normal del cuello. Sólo una cebra presentó puntuación 2, caracterizada por la apariencia notable de una cresta, pero estuvo acompañada de una buena cantidad de depósitos de grasa distribuidos uniformemente desde la nuca hasta la cruz. Cresta fácilmente ahuecada en una mano y doblada de lado a lado. Aunque todos los équidos estudiados estaban en cautiverio y semi-cautiverio, ninguno era obeso. La correlación media entre la longitud y la circunferencia del cuello de todos los équidos fue de 0,750. La correlación entre la longitud y la circunferencia del cuello para el Przewalski, el onagro persa y la cebra fue de 0,956, 0,897 y 0,333, respectivamente. En conclusión, ninguno de los équidos salvajes evaluados (Przewalski, Onagro Persa y Cebra) exhibió el fenotipo de cresta del cuello.

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aamorales13@gmail.com

INTRODUCTION

The cresty neck includes deformation of the dorsal neck, associated with degenerative changes characterized by fat infiltration, involving subcutis, nuchal ligament, spinal muscle, and multifidi muscles (Morales-Briceño, *et al*., 2017). This condition occurs in horses, donkeys and mules with high predisposition especially in some races including the Purebred Spanish, Lusitano and some crosses. Both environmental and genetic factors are associated with cresty neck (Sanchez, *et al*., 2016). There are few reports of the cresty neck in other members of the genus *Equus*. The domestic horse belongs to the genus *Equus,* which is composed of 9

extant species including horses, donkeys, hemiones, and zebras (Bailey and Binns, 1998). The Genus (Specie): *Equus przewalskii* (Mongolian wild horse) with 66 chromosomes, *Equus caballus* (Domestic horse) with 64 chromosomes, *Equus asinus* (Domestic donkey) with 62 chromosomes, *Equus hemionus onager* (Persian wild ass) with 56 chromosomes, *Equus hemionus kulan* (Kulan) with 54/55 chromosomes, *Equus kiang* (Asian wild ass) with 51/52 chromosomes, *Equus grevyi* (Grevy's zebra) with 46 chormosomes, *Equus burchelli* (Burchelli´s zebra) with 32 chromosomes and *Equus zebra hartmannae* (Hartmann´s mountain zebra) with 32 chromosomes (Bailey and Binns, 1998). The ten extant species in the genus Equus are separated by less than 3.7 million years of evolution (Leigh Mika, 2003). The phylogenetic analysis of these sequences provides further evidence that the deepest node in the phylogeny of the extant species is a divergence between two lineages; one leading to the ancestor of modern horses (*E. ferus*, domestic and *Przewalskii*) and the other to the zebra and ass ancestor, with the later speciation events of the zebras and asses occurring either as one or more rapid radiations, or with extensive secondary contact after speciation (Oakenfull, *et al*., 2000). While horses present a great spectrum of morphological differences, including size, shape, gait and colors, all breeds of horses are contained within the single species of *E. caballus*, from an evolutionary perspective, however, all horses that survived into historic times belong to one species *E. ferus* Boddaert, 1785, with three subspecies: *Equus. f. ferus* (Steppe Tarpan), *Equus. f. sylvestris* (Forest Tarpan) and *Equus. f. przewalskii* (Przewalskii's horse) or Mongolian wild horses (Groves, 1994), however, only two of the subspecies: *Equus. f. ferus* and *Equus. f. przewalskii* were commonly known and survived into historic times (Kefena, *et al*., 2012). The Persian onager *E. hemionus onager*, one of the five subspecies of *E. hemionus*, has been declining in numbers over recent decades due to poaching, habitat destruction, and resource competitionand is restricted to two isolated populations in two semi-arid ecosystems of Iran (Nowzari, *et al*., 2013). This taxon was categorized as critically endangered (CR) because of its small population size (http://www.iucnredlist.org/details/7961/0). Furthermore, onagers in zoos and the wild are regionally isolated (Ter-Beest & Schook, 2016), population as a whole is greatly affected by weather. Wind, rain and cold drive populations from the plains to the valleys of hill-valley habitats (Nowzari, *et al*., 2013). Vegetation features and water also influence habitat use, but differently for different sex and reproductive classes. Females with juveniles use plains with high-quality vegetation, whereas females without young and solitary territorial males choose those of intermediate quality (Nowzari, *et al*., 2013). Przewalski's horse (*Equus przewalskii*) is listed as endangered by the IUCN Red List and is considered to be the only true wild horse species alive today (http://www.iucnredlist.org/details/7961/0). Once native to the Gobi Desert, the Przewalski's horse, fewer than 2000 animals currently live in captivity and in reintroduction sites in Mongolia, China, and Kazakhstan (Collins, *et al*., 2012). The current population is descended from only 14 founderscaptured from the wild between 1899 and 1947. Zebras belong to the taxonomic family of horses (Equidae), which is comprised of a single genus, *Equus* (Ito, *et al*., 2015). Zebras are native to Africa and are characterized by their distinctive black and white striped coat. They occur in a variety of habitats, including grasslands, savannas, woodlands, thorny scrublands, mountains, and coastal hills, there are three species of zebra: the plains zebra (*Equus quagga*), the mountain zebra (*E. zebra*) and the Grevy's zebra (*E. grevyi*) (Ito, *et al*., 2015). While plains zebras are plentiful, various anthropogenic factors (over hunting, competition with livestock, habitat loss, etc.) have had a severe impact on Grevy's zebra and mountain zebra populations, which are now listed as Endangered or Vulnerable respectively on the IUCN Red List (Ito, *et al*., 2015 & (http://www.iucnredlist.org/details/7961/0). However, due to the ever-increasing human and livestock population pressure, habitat fragmentation and related factors, such seasonal movements of larger herbivores between their respective habitats have become infrequent (Doku, *et al*., 2007, & http://www.iucnredlist.org/details/7961/0). As a result, long-term survival of many of the protected areas and the populations of many of the larger herbivore species is not safe (Doku, *et al*., 2007). The management in captivity of this type of equidae represents a challenge, since the nutritional requirements and the physical activity directly affect the corporal condition, and can somehow accumulate fat that is evident in the crest of the neck and predispose to endocrine pathologies the equines. The aim of this study was to describe the cresty neck in horses in the Persian Onager, Przewalski's horses, and Zebra.

MATERIAL AND METHODS

Mature (5-14 years) male Przewalski´sstallions (Equus ferus przewalskii; n = 3), Persian onager (Equus hemionus onager; n = 4), and Zebra (Equus quagga burchellii; n = 4) were utilized in this study. Animals were managed in captivity and semi-captivity in the Center for Species Survival Smithsonian Conservation Biology InstituteNational Zoological Park (Washington, DC 20008, USA) and Zebra in the Miranda State Caracas-Venezuela 1083 (Private Park Zoo). Animals were examined during routine clinical evaluation (under conditions of general anesthesia). Specifically, the neck was palpated following the nuchal ligament and muscle region (Morales-Briceño, *et al*., 2017). The score of adiposity only in zebra was performed following the protocol described by Carter, et al., 2009. Scoring system included Score 0 (no visual appearance of a crest apparent tissue above the ligamentum nuchae and no palpable crest), score 1 (no visual appearance of a crest, but slight filling felt with palpation), Score 2 (noticeable appearance of a crest, but fat fairly evenly deposited from poll to withers; crest easily cupped in one hand and bent from side to side), Score 3 (crest enlarged and thickened, so fat is deposited more heavily in the middle of the neck than toward poll and withers, giving a mounded appearance; crest fills a cupped hand and begins to lose flexibility from side to side), Score 4 (crest grossly enlarged and thickened, and can no longer be cupped in one hand or easily bent from side to side; Crest may have wrinkles/creases perpen-

dicular to top line), and Score 5 (crest is so large it permanently droops to one side).All neck measurements were taken while the neck was held in a relaxed position, at approximately a 45° angle or when the animal was place in lateral recumbence (Przewalski's horse, Persian onager and Zebra). Neck length was measured from the poll to the highest point of the withers. Crest height was measured at 0.50 of neck length from the dorsal midline of the neck to estimated differentiation between the crest (tissue apparent above the ligamentum nuchae) and neck musculature, identified by palpation and visual assessment (Carter, et al., 2009). Neck circumference was measured perpendicular to this line 50% of the distance between these two structures (Diez De Castro, et al., 2012, Frank, et al., 2006, Morales, et al., 2014). A descriptive statistical analysis was performed, the coefficient of correlation and analysis of variance (ANOVA) were calculated.

RESULTS

The evaluation of the cresty neck showed a low accumulation of fat, the predominant Score was 1 in Zebra,no visual appearance of a crest, but slight filling felt with palpation.This level corresponds to the normal condition of the neck. Only one zebra presented Score 2, noticeable appearance of a crest, but fat fairly evenly deposited from poll to withers. The crest could easily be cupped in one hand and bent from side. Although all equids studied were in captivity and semi-captivity, no obesity was observed. The results are present in the following **table I**, the general correlation between length and circumference and ANOVA is shown below in **Tables II** and **III**. The general correlation between length and circumference of the neck was 0.750. The correlation between the length and circumference of the neck was 0.0956 (Przewalski's horse), 0.897 (Persian onager), and 0.333 (zebra).

DISCUSSION

The cresty neck is a severe problem affecting obese horses due to its association with equine metabolic syndrome and others pathologies.Przewalski's horses are thick, with a short neck, short limbs, and a compact build. These physical characteristics could predispose this species to the development of the cresty neck. However, due to the rugged conditions in the wild, they maintains high levels of physical activity (70% of time grazing and roam several km/day) minimizing the incidence of obesity in this species.There is a close correlation between the length of the neck and the circumference of the neck in horses, with the degree of deformity (Cresty neck) so this reference pattern was used in these species. The correlation was positive in all the species studied, this coincides with the studies in horses. In greater in the Przewalski's horse, followed by Persian onager and to a lesser extent in the zebra, these differences can be associated to the own phenotype of each species, as well as to the corporal condition determined by the corporal weight. Przewalski's horses have previously been reported to admix with domestic horse, but other author (Orlando, *et al*., 2013), reported that there is no evidence of recent admixture between the Przewalski's horse and domestic horse. This is especially important since cresty neck is common in several breeds of horse as well as in donkeys and mules. The Persian onager is a member of the Subgenus *Asinus*, is a species of the family Equidae, is a

Table I. Results of descriptive statistical measures of the neck in the Przewalski´s horse, Persian onager and Zebra (Cordoba, Spain, 02/02/2018) (Resultados de las medidas estadísticas descriptivas del cuello en el caballo de Przewalski, el onagro persa y la cebra (Córdoba, España, 02/02/2018**).**

Specie	Number	Year-sold	Length(cm)	Circumference(cm)
Przewalski´s	1		58	139
	2	5-8	48	122
	3		53	135
			SD 5 M 53	SD 8.88 M 132
Persian onager	1		41	92
	2		41	100
	3	5-7	29	75
	4		43	92
			SD 6.40 M 38.5	SD 10.35 M 89.75
Zebra	1		62	115
	2		61	112
	3	8-14	59	110
	4		60	118
			SD 1.29 M 60.5	SD 3.5 M 113.75
			SD 10.82 M 50.45	

larger than African wild ass at about 290Kg. and 2.1 m. (head-body length). A longi-linear type might be long in the body with a narrow chest; a brevi-linear type might have a heavy physique with a broad chest; and a meso-linear type would be between the two (terms such as 'rectangular' and 'square' are also sometimes used to describe body shape). The metacarpusthoracicindex indicates the relationship between the animal's mass and the legs that support it and defines three types: hypermetric (heavy), elipometric (light) and eumetric (average). The cephalic index (head width × head length) indicates the proportions of the head, including brachycephalic (with a short broad head), dolichocephalic (with a long narrow head), or mesocephalic (for a head of moderate length and breadth) (Porter, *et al*., 2006). The zebra is a medium-sized, striped equid (height of shoulder 110 to 145cm. mass 175 to 385 Kg. Males are significantly larger than females only in height at the shoulder and girth of neck (Grubb, 1981). Recent genetic analyses of both mitochondrial and nuclear DNA indicates that the genetic variation among extinct and extant Plains Zebras is no greater than that seen among modern breeds of the domestic horse (*E. caballus*) (Lau, *et al*., 2009). All three species exhibited a strong positive correlation between the length and the circumference of the neck. Only one zebra presented Score 2 the remainder Score 1. The Score was not performed in the other species(Przewalski's horse and Persian onager) for reasons of management. It is possible that since animals (wild equids) graze continuously throughout the year, animals they obtain adequatevitamin E from the diet and therefore, the fat deposition in these species is less as opposed to the domestic horse. These metabolic changes in horses and donkeys associated with increased fat deposition in the neck and lipomatosis, with severe fatty infiltration in cervical muscles, may be associated with body condition, quality of diet, exercise, management and levels of vitamin E. Currently the tools available for the study of the dorsal neck deformation (Cresty neck) in horses are clinical evaluation, the morphological study which is comprised of the degree of adiposity and the morphometric measurements of the neck (Morales-Briceño, *et al*., 2017). Although invasive techniques were not used for the study of neck ridge such as cytology and biopsy, the morphological evaluation presented consistent results in the three species studied. The possibility of expanding the study of the neck crest in other species of the same family could elucidate part of the genetic risk factor as well as management factors since these species experience different living condition in the wild compared to horse (*E. caballus*) and donkey *(E. africanus asinus*) managed in captivity. Further, multidisciplinary studies are warranted to understand environmental factors, as well as other factors such as feeding, level ofvitamin E, weight, and even genetic aspects, no evidence of Cresty neck was observed in the studied species (Przewalski´s horses, Persian onager and Zebra).

CONCLUSIONS

The cresty neck has an important genetic component, however, the management conditions observed in these species can determine the development of the cresty neck, the conditions of free-living or semi-captivity and the body condition could reduce the incidence of deformation of the cresty neck in horses and donkeys.

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