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A Case of Suspected Calcium Deficiency in a Hand-reared Garden Dormouse *Eliomys quercinus* (Linnaeus, 1766) (Rodentia: Gliridae)

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Abstract: Injured or orphaned garden dormice *Eliomys quercinus* are regularly admitted to wildlife rescue centres. During the last three years, several individuals with paralyzed hind limbs have been observed without detecting a cause. In one such individual, a fracture of a thoracic vertebra and demineralization of the bones was diagnosed. The therapeutic trial included supplementation of calcium and vitamins to improve bone mineralization and prevent further fractures. After two weeks, an improved mineralization of the bones was observed without improvement of the clinical signs. Calcium deficiency is suspected to be a problem when rearing garden dormice in captivity. Supplementing the diet with calcium may help to prevent this problem in the future.

Key words: paralysis, animal welfare, captive breeding

Introduction

Urban environments provide resources for many non-human inhabitants, some of which have lost their traditional habitats around cities due to intensive agriculture and forestry (Soulsbury & White 2016). Interactions between humans and wildlife in urban areas are not always positive because some animals can become a nuisance or carry diseases (Soulsbury & White 2016). The former is also true for dormice, which are often perceived as nuisances when they live in direct contact with humans (Büchner et al. 2018). Garden dormice *Eliomys quercinus* live in cities in some parts of their range (Nava et al. 2024). Because of this close proximity, orphaned and injured animals are regularly encountered by humans. As a result, such animals are regularly admitted to wildlife rescue centres. Overall numbers of garden dormice are declining and the species is now rare in many parts of its former range (Bertolino 2017). Compared to more common and widespread species, garden dormice are rarely cared for by wildlife rescue centres. However, in the few urban areas where they do occur, they are admitted relatively frequently (176 animals in centre in 2022; Kruse, unpublished data). As in other animals, admissions of garden dormice to wildlife rescue centres most often occur because animals are sick or injured, with juveniles admitted during the reproductive season being the most common age group and time of year for admission (Perry et al. 2020, Kruse, unpublished data).

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Research (e.g. food selection) so far has focused very little on the garden dormouse (Lang et al. 2022) and there is hardly any explicit information about the rearing, keeping and feeding of this species. Wildlife species in captivity are often fed nutritionally inadequate diets, leading to death via malnutrition or increased susceptibility to diseases. Well-known examples are insufficient calcium supply that can cause problems especially during oviposition in reptiles and birds and in juveniles during skeletal development and calcification (Foster 2014, Eshar 2016, Lumpp 2022).

During recent years, garden dormice and edible dormice with paralyzed hind legs have been noticed from time to time in wildlife rescue centres in central Germany without detecting the cause. The affected animals, which showed no internal or external signs of trauma, had partially paralyzed hind limbs; others did not fully load their hind legs or showed convulsions or tremor. As a therapy, they received veterinary care and vitamin B, analgesics and antibiotics. In none of the reported cases was there any improvement and in consultation with the attending veterinarian, it was decided to euthanize the suffering animals.

This case study of a garden dormouse with paralyzed hind legs is intended to highlight problems in the rearing and rehabilitation of dormice in general and garden dormice in particular.

Materials and Methods

In 2022, six juvenile garden dormice arrived at the rescue centre in mid-September at three to four weeks of age. Three of the young animals died after the occurrence of convulsions, two of the animals were asymptomatic and one showed paralyzed hind limbs. The animal with the suspected paralysis was presented at the Clinic for Birds, Reptiles, Amphibians and Fish at the Justus-Liebig-University Giessen, WG Wildlife Research.

At the rescue centre, the animals live in small groups and are fed native fruit, a grain mixture with sunflower seeds *Helianthus annuus*, spruce seeds *Picea abies*, pine seeds *Pinus pinea*, and dried rose hips *Rosa canina*, as well as mealworms *Tenebrio molitor*, house crickets *Acheta domesticus*, hermetia (larvae of *Hermetia illucens*) and pinkies (larvae of *Lucilia caesar*). When the garden dormouse was presented to the clinic, no paralysis of the hind limbs was detected. However, it was noticed that the animal showed a weight-bearing paresis on both hind limbs, more pronounced on the left hind limb. Flexor reflexes and deep pain were present in both hindlimbs. Together with unaffected motor and sensory functions of the front limbs, a lesion between the cervical and lumbosacral intumescence was suspected.

General physical examination revealed single furless areas with healing skin wounds in the area of the hind limbs. Beyond that, the animal did not show other abnormalities and was in good nutritional condition and general health.

Subsequently, a radiographic examination of the full body in ventrodorsal and laterolateral view was performed (Gierth HP 400, High Frequency Diagnostic X-Ray Unit, GIERTH X-Ray international GmbH, Riesa, Fujifilm Deutschland, Ratingen). To reduce stress and to get informative x-ray images inhalation anaesthesia was performed (Fischer et al. 2018). For comparison, a carcass of another dead specimen similar in size and body condition was radiographed the same way. Analysis of the radiographs revealed a curvature of the vertebral column in the region of the 7th thoracic vertebra (Th7). Contours of the cranial endplate of Th7 was irregular and the vertebral body of the sixth thoracic vertebra (Th 6) was severely reduced in length.

There was a generalized decrease of radiopacity in the vertebral bodies, most pronounced in the thoracic spine indicating a decreased mineralization status. A presumptive diagnosis of an impression fracture and spinal deformation due to calcium and/or vitamin D deficiency was made (Fig. 1).

Therapy was initiated to improve bone mineralization and to prevent further fractures. Since there are no valid data on dosages in dormice, data on other small rodents served as a guideline (Emmerich & Hein 2018). The garden dormouse initially received calcium gluconate subcutaneously once daily at a dosage of 0.5ml/kg. In addition, it received vitamin D3 in the dosage 200I.E./kg and Vitamin-B-Komplex pro inj. (Serumwerk Bernburg AG, Bernburg, Germany) in the dosage 0.2 ml/kg twice a day also subcutaneously. Over a period of seven days, the animal also received antibiosis to exclude a septicaemia due to the detected skinwounds. Enrofloxacin (Baytril®, Elanco GmbH, Cuxhaven, Germany) was used at a dosage of 10mg/kg. To optimize calcium supply, a pinch of Korvimin® (WDT, Garbsen, Germany) feed supplement was given over the garden dormouse's diet. In addition, the mealworms were fed with the same amount of Korvimin®.

Results

During the course of therapy, the garden dormouse's gait pattern only mildly improved. The left hind limb was not fully loaded after two weeks of therapy and the animal continued to lose its balance every now and then. The general condition remained unaffect-

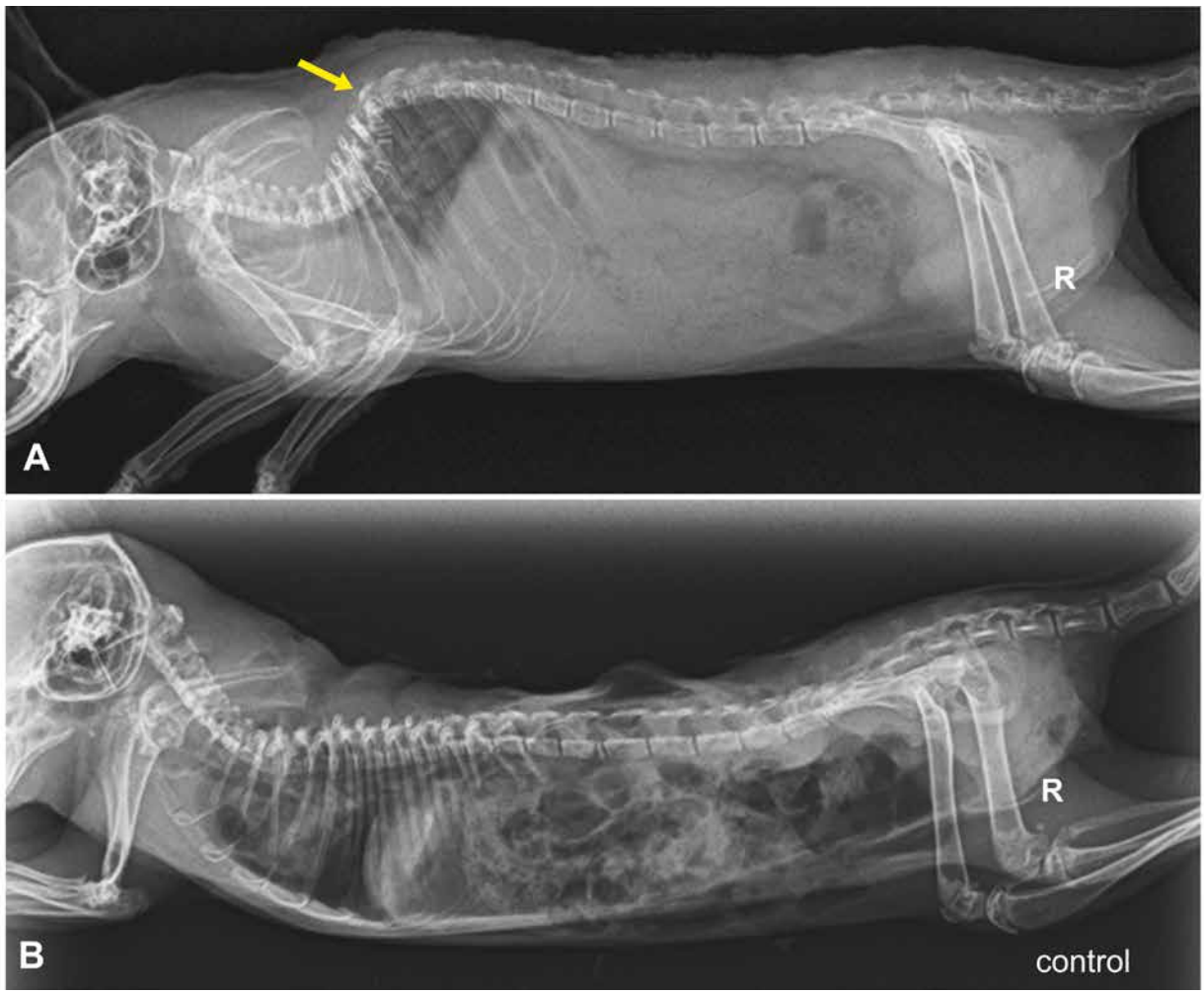

Fig. 1. Right laterolateral radiographs of garden dormice. A. Radiograph of a garden dormouse with a weight-bearing paresis, showing an impression fracture (arrow) and demineralization of the vertebral bodies. B. Radiograph of a carcass of a dead found specimen as a control. Settings 34 kV, 5.57 mAs.

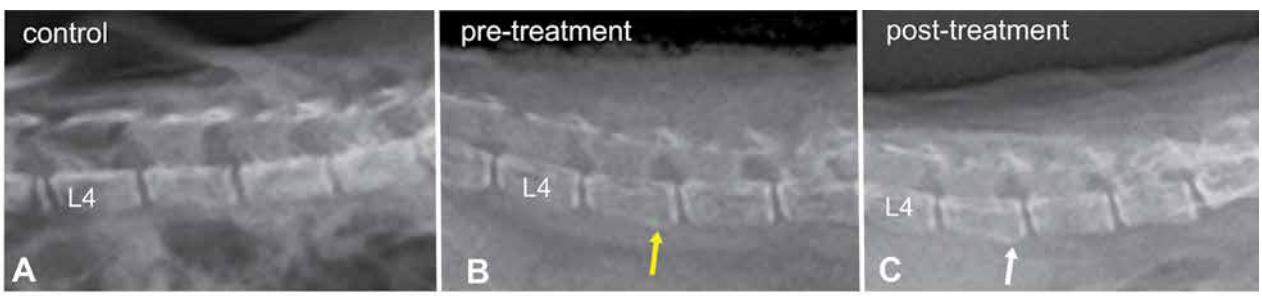

Fig. 2. Right laterolateral radiographs of the vertebral bodies of garden dormice. A. Radiograph of a carcass of a dead found specimen as a control. B. Radiograph before the treatment shows a decrease in radiopacity in the vertebral bodies, especially in the compact bone (yellow arrow) implicating a decreased mineralization status. C. Radiograph after a fourteen days treatment shows an improvement of the radiopacity in the vertebral bodies, especially in the compact bone (white arrow). Settings 34 kV, 5.57 mAs.

ed and the dormouse showed undisturbed food and water intake as well as undisturbed urination and defecation. After a few days, alopecia appeared in the area of the back, which extended further towards the head. After discontinuing antibiotics after one week, medication was reduced to once daily to reduce handling stress. After two weeks of treatment, radiographic examination was repeated. In this, an improvement in the mineralization of the bones, including the vertebral bodies, was noted (Fig. 2).

After two weeks of therapy, the garden dormouse was returned to the rescue centre with an adapted diet consisting of fruits that are high in calcium and calcium gut-loaded insects.

Discussion

The observed movement restrictions may be due to an impression fracture of the spine at the seventh thoracic vertebra following demineralization of the vertebral bodies potentially caused by calcium/vitamin D deficiency. This suspected diagnosis was made based on X-ray images. A blood test would be a useful addition in the future to be able to confirm this suspected diagnosis and to have a suitable follow-up of the therapy. However, reference values of both parameters are lacking for garden dormice and first have to be established. The symptoms of hind limb weakness, restricted movement and paralysis of the hind limbs, are comparable to those described in sugar gliders *Petaurus breviceps*, which show weakness and even paralysis of the hind limbs if the calcium supply is insufficient (Eshar 2016, Lumpp 2022). After improvement of the calcium supply of sugar gliders, the gait pattern of the animals did improve. Garden dormice in the wild primarily eat food of animal origin including insects and also fruits such as raspberries (*Rubus idaeus*), blackberries (*Rubus* sect. *Rubus*) and blueberries (*Vaccinium myrtillus*) (Büchner et al., in preparation), which are considered to be particularly high in calcium.

To prevent fractures caused by calcium/vitamin D deficiency, adequate calcium supply should be ensured during rearing. This can be achieved with fruits that are rich in calcium (Aslantaş et al. 2007, Foster 2014). However, it must be remembered that fruits bought in supermarkets do not have the same nutritional composition as those directly from nature. If fruits gathered from the wild are not available, feed supplements containing calcium need to be used. Vertebrates and more specifically laboratory rodents require diets with calcium to phosphorus ratios of between 1.2 : 1 and 2 : 1 and a calcium content of about 1 % for optimal skeletal development and calcification (National Research Council 1995, Zwart & Rulkens 1979). Feeding insects should therefore have a good ratio of calcium to phosphorus. Unfortunately, the few commercially available invertebrates provide an incomplete nutrient package without appropriate supplementation, and may adversely affect the dietary husbandry of species, which consume them as a substantial portion of their total diet. They therefore have to be fed or enriched with calcium (Anderson 2000, Finke 2013). The practice of dusting or dipping insects in calcium supplements generally provides inconsistent or inadequate levels of calcium and may adversely affect the palatability of the insects. In addition, if living insects are not consumed immediately, self-grooming or other activity may significantly reduce or eliminate the supplement. The practice of feeding insects with a high calcium diet (gut loading) has been established at many zoos and the benefits have been documented (Zwart & Rulkens 1979, Strzelewicz et al. 1985, Allen & Oftedal 1989).

However, caution must be exercised in calcium supplementation in rodents. Guinea pigs *Cavia porcellus* and degus *Octodon degus* for example absorb more calcium from the intestine when calcium intake is increased. The calcium overtake is eliminated by the kidneys and can subsequently lead to urolithiasis. However, in chinchillas *Chinchilla* spp. calcium in excess of requirements is excreted in the faeces and there is no burden on the kidneys (Ewringmann & Glöckner 2012, Wolf 2016). Since no valid data on the calcium metabolism of dormice is available, caution should generally be exercised. However, this underlines that nutrition studies of animals in the wild is highly important to mimic their diet in captivity such as in rehabilitation centres. Even in animals belonging to one family, nutrition adaptation to ecological niches can be very high, resulting in specific nutrient requirements.

The alopecia that occurred during treatment could have been due to stress from handling and being kept in a small cage as it has been described in other rodents and laboratory mice (Bechard et al. 2011, Ewringmann & Glöckner 2012). This appears in the case of stress, triggered for example by disturbances during rest periods. Fur eating could not be observed in the nocturnal garden dormouse but cannot be ruled out either. Alternatively, the alopecia could also be a reaction to the injected medication.

The findings of this case study should be taken into account in the care of injured or weakened garden dormice in wildlife rescue centres as well as in captive breeding programmes. Supplementing their diet with calcium may help prevent similar problems in the future.

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