Malocclusion in *Oryctolagus cuniculus*: causes, diagnosis, prevention, treatment

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Abstract. The present paper discusses on a frequent health problem observed in rabbits, malocclusion. Malocclusion is more frequent in domesticated rabbit breeds than in wild populations of European rabbits. Artificial selection of extremely short crania is sometimes accompanied with the occurrence of extremely short skulls. Rabbits with short skulls express secondary congenital incisor malocclusion. However, it has been proven that diet has a significant influence on skull morphology as well. Since the malocclusion is, in most cases, hereditary, the shortening of the teeth in the veterinarian's office will have to be performed periodically throughout the animal's life. Chewing favors the blunting of the teeth. To improve the situation of a rabbit suffering from malocclusion, a diet rich in fiber is recommended, which allows the pet to chew for as long as possible.
Key Words: European rabbit, brachygnathism, hypselodont, mandible, cranium.

Introduction. The health and welfare of wild and domestic animals is a topic of great relevance today in the scientific and veterinary community. Our paper discusses on a frequent health problem observed in rabbits, malocclusion.

Hereditary diseases. Hereditary diseases are the phenotypic effects of some alleles that do not give the body a good functioning (Fontanesi 2021), a good fitness, nor many descendants in the current pedological, climatic, ecological or social context. These are most often the result of mutations that occurred during the individual's lifetime, or during the lifetime of his ancestors. Other times, the alleles responsible for hereditary diseases are not mutant alleles, but archaic wild alleles, which are totally unsuited to current living conditions (Tomić & Meyer-Rochow 2011).

Hereditary diseases can occur in microorganisms, fungi, plants, animals and humans. The most studied hereditary diseases are those that affect humans, animals and cultivated plants. Hereditary diseases can sometimes be serious, or less serious, and frequently they are eliminated from the population mostly by natural selection. In the case of humans, only serious hereditary diseases are removed from the population, because medicine makes it possible to treat individuals affected by hereditary diseases (La Morgia et al 2014; Verstraeten et al 2017).

Rabbit dentition. In lagomorphs and rodents, a diastema in each jaw quadrant separates two functional units: the incisor and the cheek teeth (Reiter 2008). Lagomorphs are diphyodont, meaning they have deciduous and permanent sets of teeth. The deciduous teeth are generally lost in utero or shortly after birth (Reiter 2008). Rabbits have one pair of mandibular and two pairs of maxillary incisors, all of which have unpigmented enamel (Reiter 2008).

Malocclusion in the domestic rabbit. Malocclusion is the most common dental problem seen in rabbits and refers to the incorrect or incomplete closing of the jaws

(Druce 2015). This condition causes the two pairs of incisor teeth to grow incorrectly (Figure 1). Their blunting may therefore be irregular (Druce et al 2015), i.e. the lower incisors grow longer than the upper incisors and cause the upper incisors to curve inward, for instance (Böhmer 2015; agrobiznes.ro).

Malocclusion can cause a range of complications, from mild to very serious (Palanivelrajan et al 2017). That is why it is important that the problem is located and identified on time (Böhmer 2015). Signs of malocclusion in rabbits include excessive drooling, reduced food intake, refusal to chew hard food, inability to chew food, etc (Böhmer 2015; agrobiznes.ro).

The development of malocclusion is determined by many factors, anatomical, genetic, the type of food and the way the dentition and jaw developed during the ontogeny of the individual (Böhmer & Böhmer 2017).

Treatment and prevention. Upon careful examination of the animals, it will be possible to observe the unevenness of the incisor teeth of rabbits with dental problems (Böhmer 2015) (Figure 1), at which point the intervention of the veterinarian is necessary (Palanivelrajan et al 2017). Since the malocclusion is, in most cases, hereditary, the shortening of the teeth in the veterinarian's office will have to be performed periodically throughout the animal's life (agrobiznes.ro).

Chewing favors the blunting of the teeth (Palanivelrajan et al 2017). To improve the situation of a rabbit suffering from malocclusion, a diet rich in fiber is recommended, which allows the pet to chew for as long as possible (Proença & Mayer 2014; agrobiznes.ro).

The health of the rabbit should be checked at least once a year, but ideally twice a year, especially the incisors and molars (Proença & Mayer 2014). To partially prevent malocclusion, it is good to give rabbits proper nutrition, which should include hay, grains/special granules and twigs (Proença & Mayer 2014). Thus, the rabbits will grind their teeth evenly and the teeth will grow correctly (agrobiznes.ro).

Figure 1. Malocclusion in the domestic rabbit (*Oryctolagus cuniculus*) (original photo, by Radu Iordache).

Malocclusion in the wild European rabbit. Studies have shown that the frequency of dental problems is higher in domestic rabbits than in wild lagomorphs (Böhmer & Böhmer 2017). There are two explanations for the higher frequency of malocclusion in the domestic rabbit.

The first explanation is the diet associated with the way of life, domestic. The rabbit's food is provided by human and does not match in terms of diversity. Dietary habits must be considered as one of the major potential factors resulting in acquired malocclusions in rabbits. The results presented by Okuda et al (2007) indicated that

there is no definitive evidence that dietary habits cause malocclusions, however the authors suggest that diet is a major factor in the initiation of malocclusions in rabbits (*Oryctolagus cuniculus*).

The second explanation is that wild populations are constantly improving their mastication through evolutionary processes, through selection and adaptation (Böhmer & Böhmer 2017). That is why malocclusion is very rare in the wild European rabbit (*O. cuniculus*) and, if it occurs, it is semi-lethal or lethal. So the individual is removed from the population, producing few or no offspring. So, the probability of passing on the gene complex that causes malocclusion to offspring is very low.

A side effect of domestication in the European/domestic rabbit (*O. cuniculus*). Some domestic rabbits with malocclusion have mandibular prognathism. Due to the fact the lower jaw appears relatively too long, most authors (Harcourt-Brown 2009; Verstraete & Osofsky 2005; Böhmer & Böhmer 2017) use the term maxillary brachygnathism instead of mandibular prognathism (Botha et al 2014). This hereditary disease is indirectly a souce of malocclusion and it is most frequent in dwarf rabbit breeds (Legendre 2002; Botha et al 2014), caused by an autosomal recessive gene (*mp*). This recessive allele *mp* is responsible for differential growth of dorsal and basal skull bones, and produces anterior displacement of the mandible (Fox & Crary 1971; Botha et al 2014). Concerning the allele *mp*, Huang et al (1981) reported a penetrance of 81%. Currently the particular gene or genes responsible for incisor malocclusions are not identified (Botha et al 2014). The only way to evaluate whether an animal is a carrier or likely to be a carrier is to know whether any of its relatives, particularly siblings and offspring, are affected (Botha et al 2014).

The landmark-based geometric morphometric analysis made by Böhmer & Böhmer (2017) indicated that the craniomandibular shape of rabbits changed at different rates in the course of domestication since cranial morphometry strongly differs between domestic and wild rabbits although the dentition itself does not seem to differ significantly. This change leads to a functional imbalance of the masticatory apparatus because the regions that are associated with the generation of masticatory forces (i.e., mandible and cranium) change independently from the regions that are associated with the resistance of masticatory forces (i.e., hypselodont teeth) (Böhmer & Böhmer 2017). Consequently, this disequilibrium seems to result in a predisposition to teeth problems in domestic rabbits, the authors say.

The question is "what caused shorter skulls in the course of the domestication?". On the one side, artificial selection of extremely short crania (that is translated as "cuteness") in dwarf rabbits and many other show rabbit breeds (Botha et al 2011; Botha et al 2013) is sometimes accompanied with the occurrence of extremely short skulls (brachygnathic rabbits with a shorter maxillary diastema and secondary congenital incisor malocclusion) (Böhmer 2015). Short skull, or round head can be observed even in the case of large breeds, Grey Giant or Transylvanian Giant rabbits (Petrescu-Mag et al 2014). On the other side, it has been proven that diet has a significant influence on skull morphology as well (phenotypic plasticity) (Böhmer & Böhmer 2017). An unbalanced diet occurs frequently in domestic rabbits.

Applications of radiography in the assessment of predisposition to malocclusion. In accordance with the selective breeding for "cuteness", the analysis of Böhmer & Böhmer (2017) revealed that the skull shape was generally more quadratic in domestic rabbits, whereas wild rabbits tended to have long and flat skulls. The relative length of the nasal bone and the occiput characterize this difference, the authors say. In rabbits from the domestic breeds, the reference line that marks the dorsal limitation of the maxillary tooth apices in lateral view of the skull is defined to connect the most anterior point of the nasal bone with the most posterior point of the occipital protuberance (Figure 2, white line) (Böhmer & Crossley 2011).

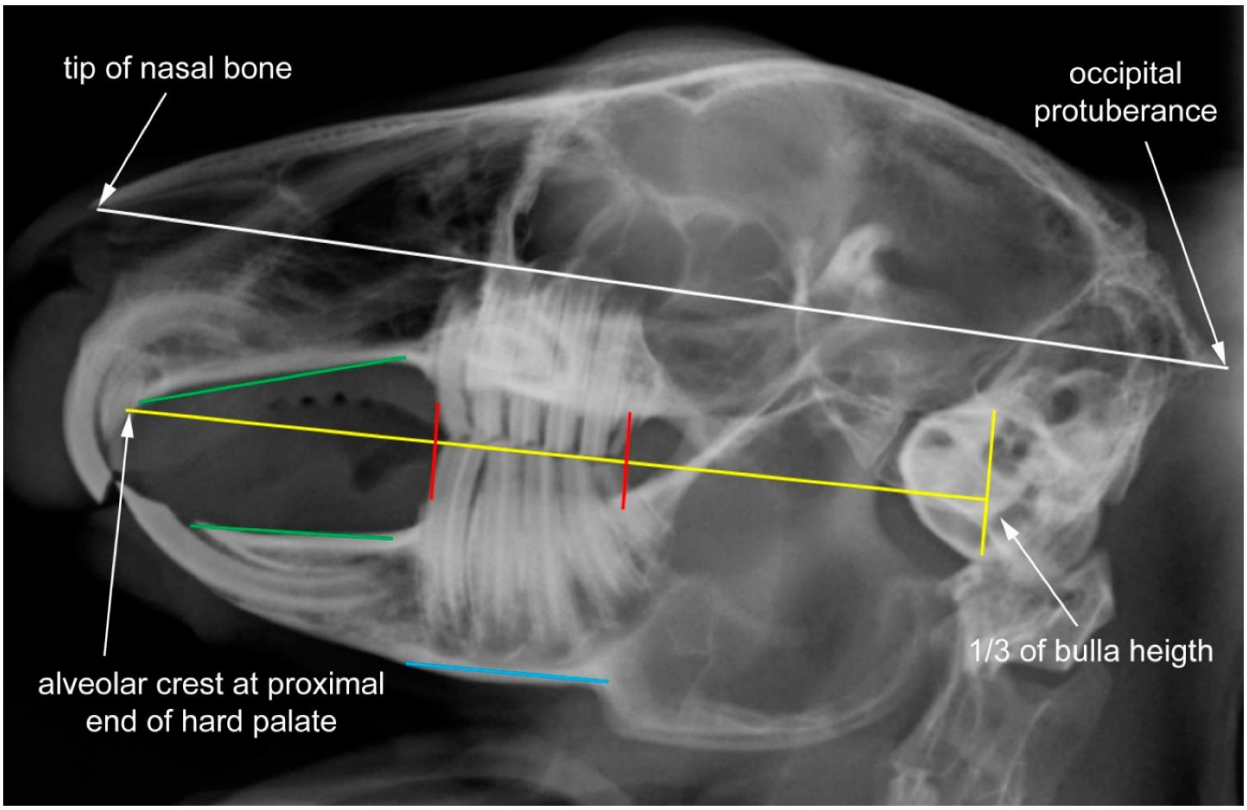

Figure 2. Species-specific reference lines superimposed on the radiograph of a clinically healthy pet rabbit in laterolateral view (Böhmer & Crossley 2011). The radiographic anatomic reference lines enable objective interpretation of malocclusion in domestic rabbits (Böhmer & Böhmer 2017).

Conclusions. Malocclusion is more frequent in domesticated rabbit breeds than in wild populations of European rabbits. Artificial selection of extremely short crania is sometimes accompanied with the occurrence of extremely short skulls. Rabbits with short skulls express secondary congenital incisor malocclusion. However, it has been proven that diet has a significant influence on skull morphology as well. Since the malocclusion is, in most cases, hereditary, the shortening of the teeth in the veterinarian's office will have to be performed periodically throughout the animal's life. Chewing favors the blunting of the teeth. To improve the situation of a rabbit suffering from malocclusion, a diet rich in fiber is recommended, which allows the pet to chew for as long as possible.

Conflict of interest. The authors declare no conflict of interest.

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