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Case Report

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# Congenital First Pharyngeal Arch Anomaly in a Holstein Friesian Calf

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## ABSTRACT

The developmental error of the first pair of pharyngeal arch processes would result in a group of malformations related to the oral cavity. These malformations can be listed as agnathia, micrognathia, brachygnathia, syngnathia, cleft palate, campylognathia, parrot beak, and strophocephalia. Campylognathia is an anomaly in which the lower or upper jaw deviated from the midline. Clinical examination of a newborn female Holstein Friesian calf showed mandibular deviation, inferior and superior cheek teeth deformation, and some other facial malformations. No similar case was detected in the history of the herd. Precise consideration of malformed animals and the extent of involvement of different structures indicates the pattern of malformation, the time of teratogenic effect, and the motive embryonic structures. In the present case, the involvement of derivatives of both maxillary and mandibular processes shows the responsibility of the first pharyngeal arch for mentioned abnormalities. In humans, different types of abnormal development of the first pharyngeal arch have been reported and so, have been classified under the "first visceral arch syndrome". But according to the infrequency of reports, this classification has not been done in domestic animals.

## Keywords

*Congenital cleft jaw, pharyngeal arch, calf, anomaly, campylognathia*

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## Abbreviations

*TRP: Temperature, Pulse, Respiratory rate*
*BMP: Bone Morphogenetic Protein*
*FGF: Fibroblast Growth Factor*
*SHH: Sonic hedgehog*
*WNT: Wingless-related integration site*



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## Introduction

The mesenchyme of the first pair of pharyngeal arches gives rise to dorsal maxillary and ventral mandibular prominences. These facial structures converge and fuse in the midline enclosing an invagination of ectoderm, the stomodeum. The ventral mandibular prominences contribute to the formation of the lower jaw while the paired maxillary prominences procedure the upper jaw [1]. The developmental error of these structures, often due to the lack of migration of neural crest cells to the first pharyngeal arch, leads to a group of malformations related to the oral cavity [2]. The developmental error of these structures would result in a group of malformations related to the oral cavity. These malformations can be listed as agnathia, micrognathia, brachygnathia, Syngnathia, cleft palate, campylognathia [3,4], parrot beak, and strophocephalia [5]. Campylognathia is an anomaly in which the lower or upper jaw deviated from the midline [6]. It has been reported in geese [7], horses [8], sheep [4], and cows [9]. Lack of maternal protein and vitamins, infectious diseases, radiation, folic acid deficiency, teratogens, and endocrine disorders at the beginning of organogenesis lead to the formation of these malformations [10,11]. In humans, this anomaly has been reported as one of several malformations of the "First Arch Syndrome". But, in animals, no classification has been made on the pharyngeal arch abnormalities. In the present work, we aim to describe a Holstein Friesian calf with severe inferior campylognathia associated with the cleft palate and oligodontia from the Kerman province for the first time.

## Case Presentation

A seven-day-old newborn female Holstein Friesian calf was referred to the veterinary hospital, Shahid Bahonar University of Kerman. On the clinical examination, mandibular deviation, respective upper and lower cheek teeth deformation, and malformation of the buccal and masseter regions on the left side of the face was seen (Figure 1). Regarding the history of the herd, it was the fifth delivery of the mother and the previous deliveries were normal, this was the first case in the herd, also no sign of poisoning was found and no medicine was used during pregnancy. TRP (Temperature, Pulse, Respiratory rate), and other vital signs have been normal. The calf had fed her mother milk. There was no symptom of respiration pneumonia, but milk was fed flow out from both nostrils during feeding. According to the severity of malformations, the animal was sacrificed and dissected. The necropsy was revealed a severe mandibular deviation to the left side of the face (Figure 2A). The ramus on the left side was short without any remnant of the condylar process (Figure 2B). The ipsilateral masseter muscle has a very poor configuration. The origin of the masseter on the facial bones was distorted and its insertion was seen as sparse fascicles on the abnormal mandibular ramus (Figure 2C). According to the shortening of the ramus, the caudal portion of the medial pterygoids was exposed. Both mandibular and maxillary oligodontia and Crooked teeth were seen in the right and left jaws. The rostral part of the hard palate was intact but a longitudinal cleft extended from the dental pad caudally to the pharyngeal region to involve both hard and soft palates (secondary cleft palate). The right external ear was intact. The left auricle has been formed but no external auditory meatus was detected. The left mandibular ramus was narrow and deformed. No other abnormalities were observed in the dissection of the brain and other organs. Also, the absence of ataxia, neurological symptoms such as turning around, head pressing, or any clinical neurological symptoms indicated the absence of this type of brain involvement and confirmed the anatomical evidence.


**Figure 1.**
A) Left view of the face of affected animal. B) Malformed buccal region results extension of the oral commissure nearby the external ear.

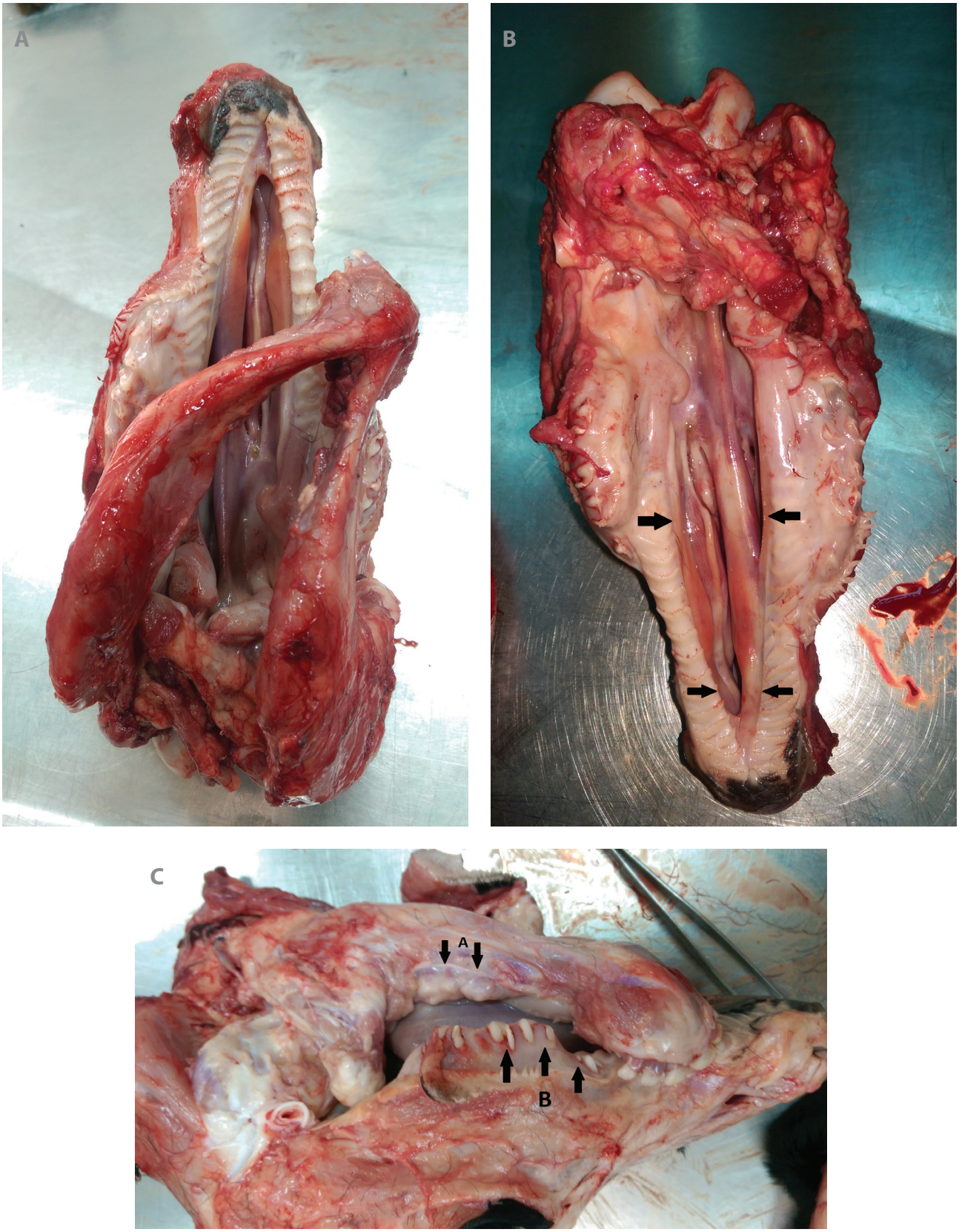


**Figure 2.**
A) Mandibular campylognathia. B) Secondary cleft palate (arrows). C) Exposition of the medial pterygoideus according to the malformation in the mandible. The oligodontia is also seen in the mandibular (arrowed A) and maxillary (arrowed B).

## Results & Discussion

According to the interaction of several organ systems, the morphogenesis of the face seems very complicated [12]. It is known that the fetal organs such as the facial processes, the pharyngeal arches, and the developing brain, would deeply relate to the formation of the face in early embryonic life [12,13]. So, in the evaluation of the facial anomalies, attention should be paid to the derivatives of each embryonic precursor. Precise consideration of the malformed animals and the extent of involvement of different facial structures, revealed the pattern of malformation, the time of the effect of teratogen, and the motive embryonic structures [14]. In the present case, all of the detected disorders incriminate the first pharyngeal arch. Secondary cleft palate deviated mandible and its rudimentary ramus, malformed masticatory muscles, and oligodontia support the involvement of the maxillary and mandibular processes of this arch. Clefts of the face are developmental disorders due to failure of closure in facial processes such as the frontonasal, maxillary, and mandibular processes. They can be asymmetric unilateral or median symmetrical clefts. In the ruminants, the most reported type of these disorders is the secondary cleft palate, which is shaped due to failure of the growth of the maxillary processes of the first pharyngeal arches, but cleft palate accompanying with the campylognathia reported as a rare anomaly in the herbivores [8]. In the present case involvement of derivatives of both maxillary and mandibular processes shows the responsibility of the first pharyngeal arch for mentioned abnormalities. In humans, different types of abnormal development of the first pharyngeal arch have been reported and so, have been classified under the "first visceral arch syndrome" [15]. But according to the infrequency of reports, this classification has not been done in domestic animals.

Since the growth of teeth and the development of the craniofacial structures are affected by similar biological factors such as BMP, FGF, SHH, and WNT [16,17], therefore in many abnormal cases, malformation of these structures are accompanied by each other, as we saw in this case.

The critical period of fusion of facial fissure and palate took place at days 34 and 56 of gestation, respectively [18]. Although a genetic basis has been determined for the cleft palate (multifactorial or autosomal inheritance in the Charolais breed) and mandibular deformations (brachygnathia inferior) (polygenic inheritance in the Simmental breed) [8,19,20] as we did not find any similar case in the herd history and previous parturitions, also there was evidence of no poisoning and no change in diet, it may be stated that the present case has been exposed to environmental teratogens such as poisonous plants and viruses (e.g. Bluetongue virus) in the first two months of embryogenesis [21].

### *Ethics statement*

This study was approved by the research ethics committee of the Shahid Bahonar University of Kerman, Iran (IR.UK.VETMED.REC). Animal care and all procedures were accomplished according to the instructions of care and use of laboratory animals.

## Authors' Contributions

BS and SD performed review literature and manuscript writing. MFA and MFA performed the clinical examination and necropsy MJ examined the animal and performed review literature.

## Competing Interests

The authors declare that there is no conflict of interest.

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