Flexural disorders in extremities are defined as the failure of the joint to reach the normal extension angle or to maintain the achieved angle. The most common musculoskeletal anomaly in newborn calves are flexural deformities (17). One percent of the calves are born with a fatal defect and 50% of these suffer flexural deformity (16). Although there are not many studies on the prevalence of tendon disorders in cattle, Anderson et al. (5) reported that 21% of the extremity problems in cattle are tendon-related.

Congenital flexural deformity is commonly characterized by the flexion of carpal, metacarpophalangeal, tarsal and metatarsophalangeal joints (1, 5, 7, 11, 12, 19). Flexural deformity can be classified as mild, moderate and severe (7). In mild deformities, a calf could walk on the tip of the hoof (7, 21); the heels, however, do not touch the ground. In moderate deformities, the animal could stand on the tip of the hoof; it could only walk, however, on the dorsal side of the ankle joint (12). Calves with severe (advanced) deformity try to stand or walk on the dorsal side of the foot, fetlock and foot joint or the carpal joint (7, 21). Furthermore, deformities could accompany arthrogryposis that includes neck, carpal and tarsal joints. Affected animals may avoid sucking milk, which complicates the case by preventing the development of passive immunity. Flexural deformity could easily be diagnosed by observing the flexed leg during inspection. In calves with untreated flexural deformities, septic arthritis could develop due to the formation of skin ulcers (12). Advanced congenital flexural deformities may lead to difficult deliveries (15).
Abnormal positions in the uterus, genetic predisposition, poor nutrition and exposure to teratogens, consumption of sudan grass and plants that contain swainsonine during the pregnancy, as well as mineral deficiencies play a role in the development of congenital flexural deformity. Furthermore, factors such as goiter, viral infections, neuromuscular disorders, lathyrism induced elastin and collagen defects are also indicative (2, 5, 15, 19, 22). However, some of the above-mentioned factors are speculative and lack scientific evidence. It was reported that further studies are needed to understand the complex details that lead to such types of deformities (15).

The present study aimed to determine serum retinol, α-tocopherol, cholecalciferol, calcium, phosphorus, magnesium, copper, iron, zinc, selenium, manganese and free T3-T4 levels in calves with congenital flexural deformities to help analyze the etiology of the disease with scientific data and develop prevention and treatment options based on the study findings.

Material and methods

Animals. The animal material of the present study included 15 calves of different race (Simmental, n = 8; Brown Swiss, n = 6; Domestic Black, n = 1), ages (1-10 days) and gender (13 males, 2 females) that were brought to Van Yuzuncu Yil University, Faculty of Veterinary Medicine, Gynecology Department clinic with walking difficulty complaints, clinically and radiologically diagnosed with congenital flexural deformity (the study group), and 15 clinically neonatal calves (control group) of different races (Simmental, n = 8; Brown Swiss, n = 6, Domestic Black, n = 1) and gender (10 males, 5 females).

Clinical examination. Anamnesis information such as the conception methods of the mothers, vitamin and mineral supplement consumption of the mothers during pregnancy, similar disorders in the previous offspring was obtained from the owners of calves with congenital flexural deformity. Next, routine physical clinical examinations such as general condition, heart rate and respiratory rate were conducted on all calves. The calves with congenital flexural deformity were diagnosed by observing the passive flexure movements of the joints and those whose foot or carpal joint position could be corrected partially during the examination were included in this group (Fig. 1). In these cases, it was determined that the cranial angle of the carpal joint was between 190-210 degrees, or the dorsal angle of the fetlock joint was between 165-180 degrees.

b) moderate: The cases that were able to stand up with support, whose hoof tip touched the ground with a vertical angle, that could not stand for a long period of time, could only take a few steps and then fall, could not achieve the normal angle with passive flexing movement of the foot or carpal joints were considered in this group (Fig. 2). In these cases, it was determined that the angles in carpal joint deformities were between 210-230 degrees. It was determined that the angles in fetlock joint deformities were between 210-230 degrees.

Angular and clinical grading of congenital flexural deformity. The grading of the flexural deformity in carpal and foot joints was conducted on the basis of the cranial angles of the joints measured on the radiograms and the posture of the extremity.

a) mild: The cases that could stand up alone or with support, could stand on the tip of the hoof, although the heels could not touch the ground, could walk timidly and with slow movements, and those whose foot or carpal joint position could be corrected partially during the examination were included in this group (Fig. 1). In these cases, it was determined that the cranial angle of the carpal joint was between 190-210 degrees, or the dorsal angle of the fetlock joint was between 165-180 degrees.

Fig. 1. Calf posture with mild flexor deformity in the forelimb

Fig. 2. Calf posture with the moderate flexural deformity in the forefoot

Fig. 3. Calf posture with the advanced flexural deformity in the forefoot
180-210 degrees. Furthermore, the cases where there was a mild deformity in both carpal and fetlock joints of the same extremity were clinically considered as moderate deformity.

c) severe: The cases that stood up with support and could not stand up because the foot contacted the ground with the dorsal, and the fetlock or carpal joints could not be adjusted to the normal position with passive movement were included in this group (Fig. 3). In these cases, it was determined that the angles in carpal joint deformities were 230 degrees or more. It was determined that the angles in fetlock joint deformities were 210 degrees or more. The cases where there were moderate deformities in both carpal and fetlock joints of the same extremity were considered as severe deformities. Furthermore, the cases with mild deformity in the carpal joint and moderate deformity in the fetlock joint in the same extremity were considered as severe. The cases with moderate deformity of the carpal joint and mild deformity of the fetlock joint at the same extremity were considered as severe cases.

Biochemical analyses. Blood samples were taken from the vena jugularis of the calves into biochemistry tubes according to the specifications. The blood samples were centrifuged at 3000 rpm for 10 minutes to obtain the blood serum and the sera were stored at −20°C until the experiments were conducted. Serum Cu, Zn, Se and Mn levels were determined with atomic absorption spectrophotometer (AA-7000, Shimadzu®), Vitamin A and E levels were determined with high performance liquid chromatography (HPLC) (Agilent 1100®), and other parameters were measured with an autoanalyzer device (Architect I4000 SR, Abbott®).

Statistical analyses. The statistical analysis of the data obtained in the study was conducted with Minitab® statistics software. One-way ANOVA test was applied to determine the significance of the variances between the groups. When the result was P < 0.05, the difference between the data was considered statistically significant.

Tab. 1. History information of calves with flexural deformity

<table>
<thead>
<tr>
<th>Case No</th>
<th>Breed</th>
<th>Gender</th>
<th>Age</th>
<th>Pregnancy method</th>
<th>Number that cows gave birth</th>
<th>Status of birth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Simental</td>
<td>male</td>
<td>1 day</td>
<td>natural breeding</td>
<td>5</td>
<td>normal</td>
</tr>
<tr>
<td>2</td>
<td>Native Black Cattle</td>
<td>male</td>
<td>5 days</td>
<td>natural breeding</td>
<td>4</td>
<td>normal</td>
</tr>
<tr>
<td>3</td>
<td>Simental</td>
<td>female</td>
<td>2 days</td>
<td>natural breeding</td>
<td>4</td>
<td>normal</td>
</tr>
<tr>
<td>4</td>
<td>Simental</td>
<td>male</td>
<td>10 days</td>
<td>natural breeding</td>
<td>7</td>
<td>dystocia</td>
</tr>
<tr>
<td>5</td>
<td>Brown Swiss</td>
<td>male</td>
<td>1 day</td>
<td>natural breeding</td>
<td>4</td>
<td>dystocia</td>
</tr>
<tr>
<td>6</td>
<td>Simental</td>
<td>male</td>
<td>3 days</td>
<td>natural breeding</td>
<td>4</td>
<td>dystocia</td>
</tr>
<tr>
<td>7</td>
<td>Simental</td>
<td>male</td>
<td>1 day</td>
<td>natural breeding</td>
<td>4</td>
<td>normal</td>
</tr>
<tr>
<td>8</td>
<td>Simental</td>
<td>male</td>
<td>4 days</td>
<td>natural breeding</td>
<td>1</td>
<td>dystocia</td>
</tr>
<tr>
<td>9</td>
<td>Simental</td>
<td>male</td>
<td>3 days</td>
<td>natural breeding</td>
<td>5</td>
<td>premature</td>
</tr>
<tr>
<td>10</td>
<td>Simental</td>
<td>male</td>
<td>2 days</td>
<td>art. insemination</td>
<td>9</td>
<td>dystocia</td>
</tr>
<tr>
<td>11</td>
<td>Simental</td>
<td>female</td>
<td>4 days</td>
<td>natural breeding</td>
<td>5</td>
<td>normal</td>
</tr>
<tr>
<td>12</td>
<td>Simental</td>
<td>male</td>
<td>1 day</td>
<td>natural breeding</td>
<td>2</td>
<td>normal</td>
</tr>
<tr>
<td>13</td>
<td>Brown Swiss</td>
<td>male</td>
<td>10 days</td>
<td>natural breeding</td>
<td>3</td>
<td>twin calving</td>
</tr>
<tr>
<td>14</td>
<td>Simental</td>
<td>male</td>
<td>8 days</td>
<td>art. insemination</td>
<td>2</td>
<td>normal</td>
</tr>
<tr>
<td>15</td>
<td>Simental</td>
<td>male</td>
<td>10 days</td>
<td>natural breeding</td>
<td>3</td>
<td>normal</td>
</tr>
</tbody>
</table>

Results and discussion

Anamnesis information revealed that calves experienced difficulties in standing up and/or walking after birth. In some calves it was stated that wounds were observed due to the contact of the front side of the joints with the ground. It was determined that mineral and vitamin supplements were not administered to the mothers during the pregnancy and the animal owners stated that this disorder was not observed in the previous offspring of the mothers (Tab. 1).

Clinical examination demonstrated that the free movement or extension of the front extremities and mostly bilateral carpal and/or phalanx joints, especially the fetlock joints, exhibited a reverse position that prevented the flexure of the extremities. It was determined that certain calves could not stand up, while others exhibited uneasy walking behavior. Decubitis wounds were observed in calves who were late for treatment. Carpal and forefoot joint cranial angles determined with the flexural deformity degrees in calf extremities and the measurements conducted on joint radiograms are presented in Table 2. Thus bilateral flexural deformity was observed in 12 calves, while flexural deformity was observed in only the right extremities of 3 calves. Among the calves diagnosed with bilateral deformity, 6 calves were diagnosed with severe deformity, 3 were diagnosed with moderate deformity, 2 were diagnosed with mild deformity, 1 was diagnosed with moderate deformity in the right extremity and severe deformity in the left extremity. All calves with unilateral deformity were diagnosed with severe deformity. Furthermore, it was found that physical examination findings such as rectal temperature, respiration and pulse were normal.

Serum retinol, α-tocopherol, cholecalciferol, calcium, phosphorus, magnesium, copper, iron, zinc, selenium, manganese and free T3-T4 values for the calves with congenital flexural deformity and healthy control group valves are presented in Table 3.

In the study group, serum magnesium, calcium, vitamin E, free T3 and T4 findings were found to be statistically higher in comparison to the control group, while the zinc level was statistically lower in comparison to the control group.

In previous studies, the incidence of congenital deformities in ruminants was reported as 26.8% by Özaydın at al. (20), as 6.58% by Belge at al. (9), and as 2.96% by Öğurtan at al. (18). Among congenital anomalies, it was reported that the musculoskeletal deformities were most prevalent (3, 9, 14, 20).

It was reported that in cases of congenital flexural deformity in
extremities, the anterior fetlock and the carpal joint are the most affected organs (1, 3, 5, 6, 9-11, 14, 19, 20). In the present study, it was determined that mostly the fetlock joint and the carpal joint were affected by flexural deformity in calves (Tab. 2).

Previous studies stated that congenital flexural deformity was more common in male calves in comparison to the females (3, 9, 10, 14, 20). In the present study, it was determined that the flexural deformity was observed in male calves more than in the females (Tab. 1). It is suggested that this could be due to the lower ability of male calves to move in the uterus since their neonatal weight is greater than that of the female calves.

Several resources classified flexural deformity into three groups as mild (first), moderate (second) and severe (third) based on the clinical appearance of the deformed extremity (1, 5, 6, 12, 13, 21). However, in these studies the classification was subjective, ignoring arthrometric or goniometric measurements. In the present study, flexural deformity was classified in three groups based on the cranial angles of the carpal and fetlock joints measured using the radiograms and the posture of the extremities (mild, moderate and severe). Joint angles were measured, and the deformity was classified on the basis of objective criteria.

It was emphasized in the literature that advanced congenital flexural deformity may lead to difficulties at birth in calves (11, 15). In the present study, it was determined that 5 calves out of 15 with moderate and severe flexural deformities experienced difficulties at birth.

Severe (advanced) level deformities may accompany arthrogryposis in the head, neck, carpal and tarsal joints, as well as dwarfism. Ulcers that cause septic arthritis on the skin can occur in the untreated animals with the deformities (5, 12). In the present study, skin erosions and ulcers were observed in severe cases. One of the calves had severe flexural deformity and dwarfism, and one exhibited arthrogryposis group anomaly (Fig. 3).

In the formation of congenital tendon diseases, factors such as abnormal posture in the uterus, jamming in the uterus due to large calf related to the heifer, genetic predisposition, poor nutrition, goiter, viral infections, ...
exposure to teratogens during pregnancy like *swains-sonine*, neuromuscular disorders, elastin and collagen defects due to lathyrism, and mineral substance deficiency are stated to play a role (2, 5, 15, 19, 22). In our study, serum values of magnesium, calcium, vitamin E, free T3, and T4 were found to be statistically higher compared to the control group, while the value of zinc was statistically lower than the control group. Zinc deficiency is reported to be associated with myotonic dystrophy type II (8). It is thought that this low level of zinc may cause flexural deformity in calves. Allen at al. (4) identified hypothyroidism in foals with congenital flexural deformity. In our study, hypothyroidism was not detected in calves with flexural deformity.

As a result, instead of subjective evaluation, objective evaluation criteria were presented in the grading of the deformity. It was also thought that it would be useful to consider objective evaluation in determining treatment options. It was thought that the addition of zinc to animal feeds during pregnancy in farms where teratogens are common can reduce these deformities.

**References**


Corresponding author: Prof. Dr. Musa Gençcelep, Faculty of Veterinary Medicine, University of Van Yuzuncu Yil, Campus, 65080 Van, Turkey; e-mail: musacelep@yahoo.com