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Clinical and Radiographic Diagnosis of Developmental Orthopedic Disease and Bone Lesions Determined in Thoroughbred Arabian Foals

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Abstract

The main objective of the present study was to determine the presence and prevalence of developmental orthopedic diseases and bone lesions, which causes huge economical looses in the purchasing of foals, in Thoroughbred Arabian foals in Tigem Anatolian Farm. The materials for this study were 50 Thoroughbred Arabian foals which were born on the same season. In total 50 foals were evaluated for clinical and radiographic examinations, blood analysis and nutrition for 12 months from birth. In addition, pasture soil and water analyzes were viewed. Variety of bone lesions were observed in 25 of 50 foals that are involved in the study. In foals hindlimb and/or forelimb sesamoiditis, osteochondrosis dissecans, physitis, subchondral cystic lesions were observed alone or together. We concluded that the clinical examination is inadequate and radiographic examinations are necessary for definitive diagnosis of developmental orthopedic diseases and bone lesions that are affecting horses' future race performance. This study also shows that the blood parameters change during foal's physical development, but these changes don't affect developmental orthopedic diseases.

Key Words: Bone lesion, developmental orthopedic disease, foal, osteochondrosis, radiograph.

Safkan Arap Taylarında Gelişimsel Ortopedik Hastalıkların ve Kemik Lezyonlarının Klinik ve Radyografik Tanısı

Öz

Bu çalışma, Tigem Anadolu Çiftliği'ndeki Safkan Arap taylarının, tayların satın alınmasında büyük ekonomik kayıplara neden olan gelişimsel ortopedik hastalıklar ile
Kemik lezyonlarının varlığını/yaygınlığını belirlemek amacıyla yapılmıştır. Çalışmanın materyalleri, Tigem Anadolu Çiftliği'nde aynı sezonda doğan safkan Arap taylarıdır. Toplam 50 tay doğumdan itibaren 12 ay boyunca klinik ve radyografik muayeneler, kan analizi ve beslenme açısından değerlendirildi. Ayrıca mera toprağı ve su analizleri incelendi. Çalışmaya alınan 50 tayın 25'inde çeşitli kemik lezyonları gözlenmiştir. Arka ve/veya ön ekstremite sesamoiditisi, osteokondritis dissekans, fizitis, subkondral kistik lezyon tek başına veya birlikte gözlenmiştir. Atların gelecekteki yarış performansını etkileyen gelişimsel ortopedik hastalıkların ve kemik lezyonlarının kesin tanısı için klinik muayenelerin yetersiz olduğu ve radyolojik incelemelerin gerekli olduğu sonucuna varılmıştır. Ayrıca kan parametrelerinin tayın fiziksel gelişimi sırasında değiştiği ancak bu değişikliklerin gelişimsel ortopedik hastalıkları etkilemediği sonucuna da varılmıştır.

Anahtar Kelimeler: Gelişimsel ortopedik hastalık, kemik lezyonu, osteokondritis, radyografi, tay.

INTRODUCTION

The term "developmental orthopedic disease" (DOD) was first defined in 1986. DOD includes osteochondritis dissecans, subchondral cystic lesions, angular limb deformities, physitis, flexural deformities, cuboidal bone abnormalities, juvenile osteoarthritis and cervical vertebral malformations (1). It affects young horses with recognizable radiographic findings that develop in the first year of life (2). Fetlock, hock, carpus, stifle, shoulder and cervical vertebra are affected most frequently (3).

The etiopathogenesis of DOD has been debated in the literature by different researchers for years (4, 5). The cause of DOD in foals is unknown, but putative factors include nutritional excesses or imbalances, genetics, growth rate, hormonal disorders, trauma and biomechanical forces, metabolic dysfunctions (6, 7).

DOD is significant problems in major horse breeding facilities worldwide. The aim of this study was to conduct a thorough investigation of the etiology of developmental orthopedic diseases and to contribute to the formation of healthy herds in Tigem Anatolian Farm.

MATERIALS AND METHODS

Animals and Protocol

This study was approved by Ankara University Animal Experiments Local Ethics Committee (2009-35-156). The material

of the project is consisted of 50 Thoroughbred Arabian foals, 18 female and 32 male, born in Tigem Anatolian Farm. Vet-Ray CR 35 brand semi-digital X-ray machine (Germany) and Vet-Ray CR 35 brand film scanner (Germany) were used for radiographic examinations. Radiography was taken on carpal and tarsal joint area with 70 kV, 2.5 mA values; 70 kV, 2.0 mA on the heel joint region. A detailed physical examination of the foals was performed. Balance, angular and length structures, posture and symmetry of standing foals were evaluated. The foals were evaluated while standing, walking and trotting on a flat surface in terms of posture and lameness. After the foals walked in the paddock, they were taken out of the paddock and a trot was run. In the last clinical examination stage, foals were longe in a circular and narrow area outside the paddock.

Sampling and Analysis

Blood samples were collected from a jugular vein of all foals after birth and then three-month intervals until foals were 12 months old. The levels of Cu, Zn, Ca, P, Fe, Albumin, Globulin, Fibrinogen, ALP and LDH, Vitamin A (Retinol), Equine GH, insulin, T3 and T4, growth hormone were evaluated. Blood samples were collected into serum tubes and centrifuged at 500 X g for 10 minutes; all samples were centrifuged within 30 minutes after collection. Serum were distributed into aliquots in cryotubes and frozen at –20°C within 90 minutes after collection. All samples were shipped to the Düzen Norwest Laboratory (Ankara/Turkey), where the aliquots were stored at –80 °C until assayed. The drinking water and stream waters of the farm were evaluated for ph, hardness, chlorine, ammonia, nitrate, nitrite and mineral. A detailed evaluation of the alfalfa, which is the main food of the foals, was also made. In terms of alfalfa; ash, fiber, energy, protein, carbohydrate, oil, moisture, minerals (copper, zinc, phosphorus, magnesium, iron), which may lead to developmental orthopedic diseases in their deficiency and/or excess, were evaluated. The pasture was analyzed in terms of ph, moisture, lime and mineral compositions.

RESULTS

The radiographic examinations and blood analysis results of the foals were evaluated 4 times, three-month periods after the birth of the foals. At the end of 12 months, 25 of them had developmental orthopedic disease and bone lesions. No lesions were observed in the other 25 foals. The findings were evaluated separately for 4 periods. Eleven of the 25 foals were female and 14 foals were male.

The first period is the period between birth and first 3 months of the foals. No DOD was found in any of the foals with physical and radiographic evaluation. The second period is the period between birth and the 6 months. In this period, DOD was found in 3 cases (6^{th}, 8^{th} and 21^{st}). Sesamoiditis was observed in the posterior heel sesame bone in 2 male cases (6^{th} and 8^{th}). Physitis in the right distal radial growth plate was seen in one female case (21^{st}). In the 2^{nd} term blood results obtained from the foals were compared with the first term blood results by statistically *student t* test. The significance control of the difference between the lesions and the lesions in terms of the measurements taken in the second period was done by *student t* test. Accordingly, a statistically significant difference was found between those with and without lesions in terms of T4 measurements ($P<0.05$). There was no statistically significant difference between the two groups in terms of other parameters ($P> 0.05$). The third period is the end of the first 9 months of the foals. With physical and radiographic evaluation in this period, DOD was found in 3 male, 2 female cases (18^{th}, 22^{nd}, 32^{nd}, 44^{th} and 48^{th}), except for the second period lesions. Sesamoiditis was found in the left posterior heel joint in one male case (18^{th}). Physitis in the right anterior distal radial growth plates and sesamoiditis in the posterior and anterior heel sesame bones were diagnosed. In one male case (48^{th}), sesamoiditis in the right anterior sesame bones, physitis the right distal of tibia, subchondral cystic lesion in the dorsal of the left tarsal joint were diagnosed (Figure 1). The statistically significant difference was found between those with and without lesions in terms of T4 measurements ($P<0.05$). There was no statistically significant difference between the two groups in terms of other parameters ($P> 0.05$). The fourth period is the end of the 12-month periods after the birth of the foals. As a result of the physical examination performed in this period. In one female case (35^{th}) was seen dragging the right posterior extremity on the ground slightly and the male case (44^{th}) had swelling in the right tarsal region. Physitis was detected in the right distal tibial radial growth plate in one female case (23^{rd}) and sesamoiditis in the anterior and posterior heel sesame bones. Sesamoiditis in sesame bones of the anterior heel in 2 male and 1 female cases (11^{th}, 36^{th}, and 40^{th}), and anterior and posterior heel in 3 female cases (5^{th}, 15^{th}, and 23^{rd}), and posterior heel in 6 male and 4 female cases (4^{th}, 10^{th}, 16^{th}, 26^{th}, 27^{th}, 33^{rd}, 35^{th}, 39^{th}, 43^{rd} and 46^{th}) were detected in the sesame bones (Figure 2). Osteochondrosis (OCD) was detected in the right tarsal joint in one male case (29^{th}) (Figure 3). The results of blood taken from the foals in this period were compared statistically with blood results of I., II., and III. periods by *student t* test. Accordingly, in terms of T4 results, there was a statistically significant difference between foals with and without lesion ($P<0.05$). There was no statistically significant difference between groups in terms of other parameters ($P> 0.05$).

The drinking water and stream water of the enterprise (Table 1 and 2) were evaluated in terms of pH, hardness, chlorine, ammonia, nitrate, nitrite and mineral. Grassland-soil from the foal's living area is also analyzed for pH, moisture, lime and mineral (Table 3). A detailed evaluation of the alfalfa, which is the main food of the foals, was also made (Table 4). It was evaluated in terms of minerals (copper, zinc, phosphorus, magnesium, iron), which can lead to developmental orthopedic diseases in foals.

Figure 1. Radiographic view of the physitis (white arrow) at the lateral (A) and anteroposterior (B) positions in the right distal tibial growth plate in case 48; lateral radiographic view of the subchondral cystic lesion just dorsal to the left tarsal joint (white arrow) (C); appearance of the sesamoiditis (white arrow) (D) on the lateral oblique radiograph of the heel joint in the right anterior sesame bone.

Figure 2. External oblique radiographic view of sesamoiditis (white arrow) in the right posterior sesame bone (Case number: 26).

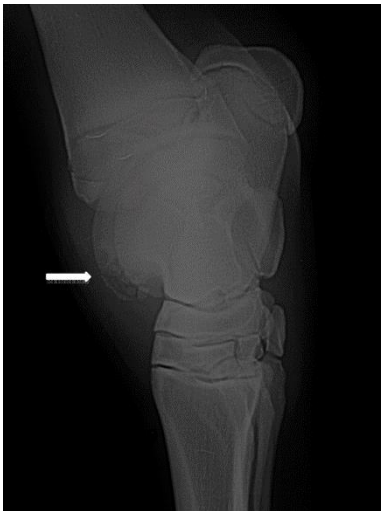

Figure 3. The presence of OCD (white arrow) in the right tarsal joint (Case number: 29).

Table 1. Drinking water analysis results

Parameters	Unit	Chemical analysis results	Maximum concentration
pH (20ºC)		7,3	6,5-9,5
Stiffness	FS	61,5	
Ca	mg/L	167,5	
Mg	mg/L	48	
Total alkalinite	mg CaCo/L	153,8	
NO2	mg/L	0,007	0,5
NO3	mg/L	45,4	50
NH3	mg/L	0,41	0,5
Free Cl	mg/L	<0,1(2)	
Total Cl	mg/L	0,15	
Cl	mg/L	153	250
Electrical conductivity	**mS/cm**	**1,29**	**2,5**

Table 2. Stream analysis results

Parameters	Unit	Chemical analysis results	Maximum concentration
Ph (20ºC)		8	6,5-9,5
Stiffness	FSº	43,3	
Ca	mg/L	98,4	
Mg	mg/L	45,6	
Total alkalinite	Mmg $CaCo_3$	324,6	
NO2	mg/L	0,06	0,5
NO3	mg/L	7,4	50
NH3	mg/L	<0,01(2)	0,5
Free Cl	mg/L	<0,01(2)	
Total Cl	mg/L	<0,01(2)	
Cl	mg/L	33,6	250
Electrical conductivity	Ms/cm	0,89	2,5
Na	mg/L	34,7	200
Boron	mg/L	1,5	1

Table 3. Soil sample analysis results

Parameters	Unit	Chemical analysis results
Ca	mg/Kg (dry weight)	86426,5
Mg	mg/Kg (dry weight)	11247,2
Fe	mg/Kg (dry weight)	15851
Mn	mg/Kg (dry weight)	564,2
Cu	mg/Kg (dry weight)	19,8
Zn	mg/Kg (dry weight)	43,8
K2O	mg/Kg (dry weight)	0,7
P2O5	mg/Kg (dry weight)	110
Boron	mg/Kg (dry weight)	3,4
Total nitrogen	%(dry weight)	0,4
Total organic matter	%(dry weight)	11,9
Salinity	µs/cm	881
Ph		8
Moisture	%	27,1
Lime	%	9
Satured with water	%	51,3
(1) MDL, Method Detection Limit		

Table 4. Alfa Analysis Used in Foal Nutrition

Parameters	Unit	Chemical analysis results
Humidity	%(m/m)	7,7
Ash	%(m/m)	10,5
Protein	%(m/m)	12,9
Fat	%(m/m)	1,1
Fiber	%(m/m)	34,6
Carbohydrate	g/100 g	67,8
Energy	Kcal/100 g	194,3
Ca	mg/Kg	10326
Fe	mg/Kg	66,5
Mg	mg/Kg	833,8
Cu	mg/Kg	4
Zn	mg/Kg	6,9
P	mg/Kg	827,5

DISCUSSION AND CONCLUSION

There are many orthopedic problems that can occur during the development of foals from birth. Due to their high incidence, orthopedic problems are responsible for significant losses in the horse industry. The injuries of the carpal joint region bones should be examined carefully because it's frequently seen in racehorses (8). Careful control of the tarsal joint is also important. The cause of hindlimb lameness is usually caused by this joint (9). In this study, there was no abnormality except for the detection of swelling of the tarsal joint region in one case in the fourth period. The basic gait examination is performed on a hard ground, looking at whether the horse shows any lameness while walking and running slowly. In the IV. period examination, it was observed that one case was dragging the right posterior extremity on the ground slightly while walking. It was observed that gait examination did not provide enough information to confirm the diagnosis of the cases.

There are contradictory findings in the literature regarding the effect of gender. The incidence of the disease is 2 times higher in males and several other studies have reported a higher prevalence tendency in males (5, 10). In this study, it was determined that gender was not a significant difference in the appearance of the disease, although it was a slight bias towards males.

Radiological examinations are an important imaging modality that provides information about bones and joints (11). Denoix et al. (2013) emphasized that radiography is the primary diagnosis method in locating, finding the degree and early diagnosis of juvenile osteocondral conditions (JOCC) in their study in 392 foals (12). In this study, it was concluded that intermittent radiographic evaluations in foals are an extremely useful diagnostic method for diagnosing the lesion even at the initial stage.

Osteochondrosis is one of the most important and most common developmental orthopedic diseases of horses (13, 14). Gorissen et al. (2018) determined that there is a direct proportion between OCD and BT/TV ratio using micro-CT and polarized light microscope in their study with 5 newborn (0-12 hours) and 4 foals of different ages and 3 adult horses (15). In present study, OCD was detected in only one case (29^{th}). As a result, there was no need to evaluate the BT/TV ratio in this study.

Physitis is a problem with the growth plates of some long bones in young horses (4). In 5 cases were diagnosed with physitis on the distal radial growth plate in present study. Radiographs with irregularity of growth plaques, blisters, dilatations and lytic views were determined as the most evident symptoms.

Sesamoiditis is a disorder predominantly affecting 1-year old to 2-year-old foals (16). In a study, it was found that the sesamoiditis (≥grade 3, modified Spike-Pierce scale) with one or more irregular vascular channels wider than 2 mm were 5 times more likely to develop clinical suspensory ligament branch injury (SLBI) symptoms in the first year of racing training (17). Since the cases in this study were not severe, SLBI was not encountered. In another study that similar rate to our work, the population of 50 Thoroughbred yearlings, 66% demonstrated some degree of sesamoiditis. This finding is consistent with other studies that have shown sesamoiditis to be a common condition (18). Horses with enlarged vascular canals, within their sesamoids as yearlings, start fewer races and earn less prize money than horses with normal vascular canals (19). Knowing the spontaneous healing capacity of some lesions is useful in helping to decide the appropriate management (14). There is also axial sesamoiditis or osteitis of the proximal sesamoid bones in horses, which is described as a rare condition with the limited number of cases described in the last 5 years reported in the literature (20). In the present study that sesamoiditis findings in posterior heel in 10 cases, anterior heel in 3 cases, and both anterior and posterior heel in 3 cases were encountered. This finding is consistent with other studies that have shown sesamoiditis to be a common condition. The clinician should consider this during the pre-purchase examination of the foal.

In studies that the lactate dehydrogenase (LDH) of thoroughbred horses showed significant increased after exercise ($P<0.05$) at 5. minutes then decreased gradually at 15 minutes till reach to normal baseline after 60 minutes (21, 22). LDH is a physiological biomarker that can return to its normal level. In this study we noticed that LDH level to be higher in one case (29^{th}) however it was not considered as important because it is within physiological limits.

There is contradictory evidence regarding the role of exercise in the development of osteochondrosis; however, most researchers agree that moderate exercise is necessary for normal functional adaptation of cartilage during early development, and little or excessive exercise may contribute to the development of osteochondrosis (23). Horses under intense physical activity develop electrolyte and acid base abnormalities. Hypocalcemia and hypomagnesemia are consistent findings in the exercise of horses (24). When we evaluated the results, the presence of OCD lesions in only one case thought controlled exercise. However, there is still a need for comprehensive studies to be done by keeping all

other values constant and only by changing the exercise program.

As a result of this study, DOD, which is frequently encountered in foals, can be determined by radiographic examination and blood analysis in 3-month intervals after birth. Regular maintenance and feeding of the foal from the birth, improvement of controlled exercise and pasture conditions plays an important role in DOD development. As a result, factors leading to DOD should be monitored closely to prevent its development.

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REFERENCES

1. Şirin Ö, Alkan Z. (2010). Developmental Orthopedic Disease in Foals. Kafkas Univ Vet Fak Derg. 16: 887-892.
2. Olstad K, Ekman S, Carlson CS. (2015). An Update On the Pathogenesis of Osteochondrosis. Vet Pathol. 52: 785–802.
3. Jeffcott LB. (2004). Developmental Diseases Affecting Growing Horses. The Growing Horse: Nutrition and Prevention of Growth Disorders. pp. 231- 245. Dijon, France.
4. Douglas J. (2003). Physitis. In: Diagnosis and Management of Lameness in the Horse. Ross MW, Dyson SJ (eds), pp.554-556. Saunders Elsevier, Missouri, USA.
5. Lepeule J, Bareille N, Valette J, et al. (2008). Developmental Orthopaedic Disease in Limbs of Foals: Between-Breed Variations in The Prevalence, Location and Severity at Weaning. Animal. 2: 284-291.
6. Mcllwraith CW. (2004). Developmental Orthopedic Disease: Problems of Limbs in Young Horses. J Equine Vet Sci. 24: 475-479.
7. Wright IM, Dyson SJ, Kannegieter N, et al. (1999). Developmental Orthopaedic Disease. In: The Equine Manual. Higgins AJ, Wraight IM (eds). pp. 911-919. Saunders Elsevier, Missouri, USA.
8. Baker WT, Slone DE, Ramos JA, et al. (2014). Improvement in Bilateral Carpal Valgus Deviation in 9 Foals After Unilateral Distolateral Radial Periosteal Transection and Elevation. Vet Surg. 44: 547–550.
9. Ross MW, Dyson SJ. (2003). Diagnosis and Management of Lameness in the Horse. pp.534-570. Elsevier, Philedelphia, USA.
10. van Weeren PR, Sloet van Oldruitenborgh-Ooste, Barneveld A. (1999b). The Influence of Birth Weight, Rate of Weight Gain and Final Achieved Height and Sex on the Development of Osteochondrotic Lesions in A Population of Genetically Predisposed Warmblood Foals**.** Equine Vet J Suppl. 31: 26-30.
11. Jacquet S, Robert C, Valette JP, Denoix JM. (2013). Evolution of Radiological Findings Detected in the Limbs of 321 Young Horses Between the Ages of 6 and 18 Months. Vet J. 197: 58-64.
12. Denoix JM, Jacquet J, Lepeule N, et al. (2013). Radiographic Findings of Juvenile Osteochondral Conditions Detected in 392 Foals Using a Field Radiographic Protocol. Vet J. 197: 44–51.
13. Bourebaba L, Löcken M, Marycz K. (2019). Osteochondritis dissecans (OCD) in Horses – Molecular Background of its Pathogenesis and Perspectives for Progenitor Stem Cell Therapy. Stem Cell Rev. 15: 374–390.
14. Marshall M. (2007). Developmental Orthopedic Disease in Thoroughbred Foals an Epidemiological Comparison Between A Stud in Ireland and A Stud in Australia. Thesis. University of Sydney Faculty of Veterinary Science, Sydney.
15. Gorissen BMC, Wolschrijn CF, van Rietbergen B, et al. (2018). Trabecular and Subchondral Bone Development of the Talus and Distal Tibia from Foal to Adult in The Warmblood Horse. Anat Histol Embryol. 47: 206–215.
16. Reesink HL. (2017). Foal Fractures: Osteochondral Fragmentation, Proximal Sesamoid Bone Fractures/Sesamoiditis, and Distal Phalanx Fractures. Vet Clin North Am Equine Pract. 33: 397-416.
17. McLellan J, Plevin S. (2014). Do Radiographic Signs of Sesamoiditis in Yearling Thoroughbreds Predispose to the Development of Suspensory Ligament Branch Injury? Equine Vet J. 46: 446-450.
18. Plevin S, McLellan J, O'Keeffe T. (2016). Association Between Sesamoiditis, Subclinical Ultrasonographic Suspensory Ligament Branch Change and Subsequent Clinical Injury in Yearling Thoroughbreds. Equine Vet J. 48: 543-547.
19. Spike-Pierce DL, Bramlage LR. (2003). Correlation of Racing Performance with Radiographic Changes in The Proximal Sesamoid Bones of 487 Thoroughbred Yearlings. Equine Vet J. 35: 350–353.
20. Le Roux C, Carstens A. (2018). Axial Sesamoiditis in the Horse: A review. J S Afr Vet Assoc 89: a1544.
21. Kratz A, Lewandrowski KB, Siegel AJ, et al. (2002). Effect of Marathon Running on Hematologic and Biochemical Laboratory Parameters, Including Cardiac Markers. Am J Clin Pathol. 118: 856-863.
22. Mami S, Khaje G, Shahriari A, et al. (2019). Evaluation of Biological Indicators of Fatigue and Muscle Damage in Arabian Horses After Race. J Equine Vet Sci.78: 74-78.
23. van Weeren PR, Barneveld A. (1999a). Study Design to Evaluate the Influence of Exercise On the Development of the Musculoskeletal System of Foals Up to Age 11 Months. Equine Vet J. 31: 4-8.
24. Toribio RE. (2011). Disorders of Calcium and Phosphate Metabolism in Horses. Vet Clin North Am Equine Pract. 27: 129-147.

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