

The relationship of standing up of warmblood foals and the prevalence of osteochondrosis, between farms

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Abstract

Osteochondrosis (OC) is a commonly diagnosed and clinically important joint disorder that is defined as a focal disturbance of enchondral ossification. The pathogenesis is multifactorial, but in most recent literature the failure of blood supply to the growing cartilage has been seen as a factor of major importance. Doubts about heritability of OC became clear when different joints appeared to be involved at different ages, so environmental factors are likely. Cartilage injury (with fragmentation) due to pressure changes when the leg slips, has been observed. This fragmentation can occur directly when a leg slips, or indirectly due to avascular necrosis caused by injury of the juvenile circulation. Between 5 and 8 months, the developing cartilage is susceptible for these injuries. We tested the hypothesis that there is an association between the way of standing up in foals and the development of OC.

We observed the standing up behavior of 45 warmblood foals between the age of 6 to 9 months at five different farms, with different housing / bedding. Foals were observed using surveillance tube cameras, and stored on VHS videotapes (3-4 hours/day; total 24 h per farm). We scored whether there was a normal stand up (NS) or a slipping limb (SL). The standing up was scored by means of a predetermined ethogram. The prevalence of OC was determined using a mobile x-ray machine and standard criteria (A=OC absent, B-E=OC present).

A two-way between groups analysis of variance was performed on different moments (OCD 5 months and 12 months), to explore the relationship between the prevalence of OCD, management factors and slipping legs. OCD was divided in two groups: 0 (OCD absent) and 1 (OCD present). The farms were divided on management factors into two groups: 0 (Low Risk), 1 (High Risk). The first ANOVA was performed with OCD results of 5 months. The relation between slipping legs and the prevalence of OCD was not statistically significant, $p=0,423$. But there was a significant relation between farms and slipping legs, $p=0,004$; however the effect size was small (partial eta squared = 0,231). The second ANOVA was performed with OCD results on 12 months. The relation between slipping legs and the prevalence of OCD was

not statistically significant, $p = 0,514$. But there was a stronger significant relation between farms and slipping legs, $p = 0.001$; however the effect size was small (partial eta squared = 0,246).

There was no significant relation between the prevalence of OCD and the sliding ratio. But high risk farms have significant more slipping foals than low risk farms. Further investigation is needed to prove the relation between sliding and the development of OCD.

Keywords: osteochondrosis, standing up behavior, warmblood foals, farms, management factors

1. Introduction

Osteochondrosis (OC) is a clinically important joint disorder that occurs in human beings and multiple animal species, most commonly in pigs, horses and dogs. It is defined as a focal disturbance of endochondral ossification and is known as a multifactorial disease. The most described etiologic factors are heredity, rapid growth, trauma and dietary imbalances, but the initial step in the pathogenesis remains unclear. Heredity is assumed as the principal step in the pathogenesis because in different species a lot of studies have been done with compelling evidence that inheritance is important (Ytrehus, Carlson, Ekman 2007). Heredity was questioned by a study in 1999 however, as he described normal and abnormal OC appearances in the stifle joint at a different timepoint appearing than in the hock joint (Dik, Enzerink, van Weeren 1999). In the hock these were permanent from an age of 5 months, while in the stifle these were permanent from the age of 8 months (van Weeren and Barneveld 1999). From the research in pigs the suggestion was made that blood supply plays a role in the pathogenesis of OC. In 1995 Carlson et al. was the first who proved this theory of OC pathogenesis in foals. The early lesions of OC in pigs and foals are very similar. Only foals between the age of 3 weeks and 5 months are associated with necrotic cartilage vessels, as there are no cartilage canals present in foals older than 7 months of age, so then nutrients will just diffuse to the growing cartilage (Carlson, Cullins, Meuten 1995). A recent study pointed out that vessel failure is associated with ischemic necrosis of growing cartilage ((Olstad and others 2007)). In relation to that blood supply, exercise is an important factor. Exercise in foals is important for skeletal development and bone ((Jeffcott 1991);(Rogers and others 2008)). Furthermore, the relationship between exercise and box-rested foals was done. Exercise did not significantly influence numbers of lesions, but at 5 months there was a tendency towards more severe lesions for box-rested foals (van Weeren and Barneveld 1999). Also recent research proved a relationship between the housing system and feeding level and the development of osteochondrosis in pigs (van Grevenhof and others 2011). This investigation showed a significant relationship between the prevalence of osteochondrosis on deep litter and conventional floor; rapidly growing pigs housed on conventional, slippery flooring developed more osteochondrosis than those housed on a deep litter floor with restricted feeding.

A foal has well-developed joints and long legs, but his weak muscles and tendons causing a risk for different movements other than the normal sagittal movements at the first months of age. We believe the greatest risk for different movements occurs during the standing up of young foals. One or more legs can slip sideways during the standing up due to weak muscles/tendons and/or a slippery floor, or an aberrant way of standing up can cause pressure changes in the joints. First fragmentation can occur directly. Also the juvenile circulation of the cartilage can be injured due to these pressure changes and causing avascular necrosis. Repeated injury of the juvenile circulation and necrosis will cause fragmentation of the developing cartilage and OCD has been developed. Between 5 months and 8 months of age, the developing cartilage is susceptible for injuries and though the development of OCD.

Each farm has a different way of housing, so management factors seem to be very important. These variations between farms are similar to the differences between the deep litter floor and conventional floor in pigs. The renewal and sort bedding of foals varies between farms; straw or nothing. A higher risk on different movements occurs on a slippery floor; a more slippery floor occurs when farms who renew their straw every day other than farms with no new layer. Exercise is another distinctive factor between farms. Exercise can improve the circulation and improve the development of cartilage and bone and reduce the risk of the development of OCD). Also the space in the stable is of importance, in the high risk group foals have less space with more foals. There is a greater risk of different movement/slipping legs because a foal has to avoid other foals during the stand-up.

The aim of this study was to examine the hypothesis that there is an association between the way of standing up in foals and the development of OCD. This is supposed to happen when merely a hindlimb slides sideways and gets into an out of its regular plane of sagittal movement. Thus, cartilage will become directly injured occurring due to (patellar) bone to (condyl) bone peak pressures (eventually with 1st fragmentation) or indirectly yet onto the juvenile circulation (eventually with 2nd fragmentation) of the foals in their periodically susceptible joint.

2. Materials and Methods

2.1 Participating farms

Five different farms are selected to participate our study, all located in the Netherlands, province Drenthe or Overijssel. A total of 45 foals was collected for our study. Each farm has a different way of housing, therefore we will describe each farm below and highlight the important differences between these farms. As described above, important differences between farms are their way of bedding and their way of exercise.

Farm 1 was a small breeding company with only foals of own breed. This farm participates with six

different foals, which were divided in groups of 2 over 15 m². On average they each had 7,5 m² of moving space, for 21-22 hours a day. They were being held in an inner of 40 by 20 meter for two to three times a day for 1 hour. In the stable they were bedded on deep litter with a new layer of straw each week. Average height and age of the foals at this farm were respectively 1.40 meter and 6 months and 26 days.

Farm 2 was a large breeding company with only foals of own breed. This farm participates with 12 foals, which were divided in groups of five over 40 m². On average they each had 5 m² of moving space, for 22-23 hours a day. They were allowed in a paddock of 40 by 20 meter for 1 to 2 hours daily. In the stable they were bedded on deep litter with a new layer of straw each week. The average height and age of the foals at this farm was respectively 1.36 meter and 8 months and 4 days.

Farm 3 was a small breeding company with only foals of own breed. This farm participates with six different foals which were housed in a group of seven over 128 m². On average they each had 18,3 m² of moving space for 24 hours a day. They were held in an inner of 40 by 20 for two to three times a week. In the stable they were bedded on deep litter with a new layer of straw each week. Average height and age of the foals at this farm was respectively 1.37 meter and 8 months and 23 days.

Farm 4 was a small farm which participates in the personal breeding of six foals. They were selected by the owner before participation. The foals were housed in a run-in shed with moving space outside of 10.000 m² for eight foals. So each foal has 1250 m² moving space 24 hours a day. In the shed they are bedded on deep litter without straw, only manure. Average height and age of the foals at this farm was respectively 1.40 meter and 8 months and 6 days.

Farm 5 was a rearing establishment; different owners were housing their foal(s). The background (housing as foal, breeding information) of these animals was unknown because each foal has a different owner. This farm participates with 15 foals which are divided in groups of eight over 40 m². Meanly, they each had 5 m² moving space for 23 hours a day. They are put into a paddock of 40 by 10 meter for 1 to 1,5 hours daily. In the stable they are bedded on deep litter with a new layer of straw each week. Other factors that participate in our investigation are the average height and age which were respectively 1.44 meter and 8 months and 1 day.

2.2 Standing up behaviour observations

Observations of differences between normal stand up and a slipping limb was done at each farm, when the foals were between the age of 6 and 9 months. Black-white surveillance cameras were used to record each group of foals. The images were recorded with a video recorder (Mitsubishi/Sanyo) and stored on VHS videotapes of 3 to 4 hours, with a total of 24 hours per group.

A splitter (EQM 100 Monoquad) has been used to create one image containing different views of the stable. Each foal is judged by an ethogram. An ethogram contains information about the foal and tables for observing particular behaviour. Here we scored whether there was a normal stand up or a slipping limb. A slipping limb is divided in which limb was slipping and the gradations of slipping (short, medium, far). We questioned the farm owners about bedding and exercise (paddock as example) to compare and explain the prevalence of a slipping limb or OCD.

2.3 Scoring OCD

X-rays were taken with a mobile x-ray machine to determine the prevalence of OCD. Because OCD becomes permanent between the age of 5 to 8 months, the x-rays are taken at the age of 6 and 12 months. They are judged at the University of Utrecht using the standard criteria: A up to D. Score A means no abnormalities, B is a flattening of cartilage, C is a slight irregular cartilage, D is severe irregular cartilage with small fragmentation and score E is a severe irregular cartilage with large fragmentation.

3. Results

3.1 Data

We used Excel to match each foal with its observation. Then we coded each observation for the way of standing (normal stand up or a slipping limb) and the absent or presence of OCD. The participating farms were divided in low risk (farm 3 and 4) and high risk (farm 1, 2 and 5) based in their way of housing. Moving space is the most important and distinctive factor between these farms, in the high risk group foals have less moving space with more foals than the low risk group. The low risk group had a moving space 24 hours/day against 1 to 2 hour/day in the high risk group.

3.2 Prevalence of OCD

Each foal was checked on their prevalence of OCD and scored each in a category. These categories are made according to the highest OCD grade and expressed in percentages. Foals that only scores A in all joint locations were grouped in the =A, foals that scores B as highest

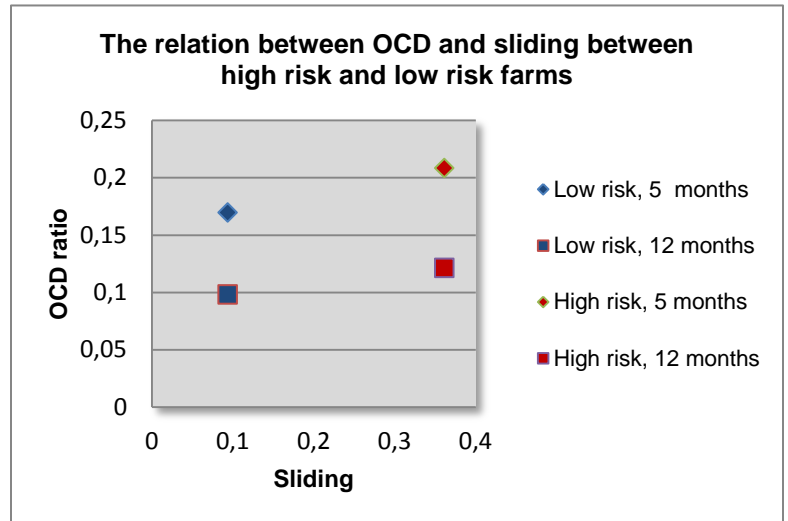
Prevalence	OCD 5 months		OCD 12 months	
	High risk	Low risk	High risk	Low risk
= A	16,7	33,3	35,7	57,1
≤ B	25,0	22,2	14,3	7,1
≤ C	11,1	11,1	28,6	21,4
≤ D	19,4	19,4	14,3	7,1
≤ E	2,8	8,3	7,1	7,1
MD	25,0	5,6		
Total	100	100	100	100

grade over all joint locations were grouped in ≤ B, foals that scored C as highest grade over all joint locations were grouped in ≤ C, foals that scores D as highest grade over all joint locations were

grouped in $\leq D$ and foals that scores E as highest grade over all joint locations were grouped in $\leq E$. Also the groups were divided into high risk and low risk. Foals were missed in the X-rays at 5 months of age were divided in Missing Data (MD).

3.3 Averages

As described above, we divided the participating farms in high risk, low risk and the prevalence of OCD. In the graphics on the right, we calculated the averages of these groups to create a clear image of the data. The prevalence of OCD decreases between 5 and 12 months in both groups, but the OCD ratio in high risk farms stays a little higher than in low risk farms. However, the sliding average is has a greater difference between these two groups.



3.4 Statistics

We performed two two-way ANOVA's to examine the relation of the prevalence of OCD and slipping between the high risk and low risk groups. The independent variables were OCD and groups and the dependent variable was the slipping ratio. OCD was divided in 0 (OCD absent) and 1 (OCD present), also groups was a categorical variable; 0 (low risk) and 1 (high risk). The analyses were done with two different OCD data: OCD judges on the age of 5 months and OCD on the age of 12 months.

3.4.1 Two-way ANOVA, 5 months

There was no significant relation between the prevalence of OCD and the slipping ratio ($P= 0,423$). A significant relation was seen in the relation between the groups and the slipping ratio ($P= 0,004$), however the effect size was small (partial eta squared = $0,246$).

3.4.2 Two-way ANOVA, 12 months

There was no significant relation between the prevalence of OCD and the slipping ratio ($P= 0,514$). Also in this test, there was a significant relation between the groups and the slipping ratio ($P=0,001$), however the effect size was small (partial eta squared = $0,246$).

4. Discussion

The aim of this study was examining the hypothesis that there is an association between the way of standing up in foals and the development of OC(D). The results of this relation were not statistically significant; however some indications were noted for further investigation. There was a significant relation between the high risk and low risk farms and the sliding ratio. High risk farms had a significant higher sliding ratio than low risk farms. So there is a strong indication for a relation of management factors and foals slipping.

4.1 OCD prevalence

There was a difference in OCD prevalence between high risk farms and low risk farms in the averages (in the graph). The high risk farms had more OCD at 5 months and 12 months than low risk farms. This difference was not statistically significant, but with a bigger sample this difference may become clearer because in other species there was a statistical difference (van Grevenhof and others 2011). This research showed a significant relation between the prevalence of OCD and the way of housing; conventional (more slipping) had a higher OCD prevalence than deep litter (less slipping).

4.2 Further investigation

To get more reliable results, there are certain things which can be improved for further investigation. First, the research can be repeated with more and younger animals; a bigger sample will get more reliable results. We did our investigation with animals between 5-12 months old. At this age, muscles (and tendons) are stronger than in newborn foals. When muscles are stronger, the sliding risk decreases and the relation between OCD and sliding can be influenced. Maybe the direct and indirect trauma has occurred at the first days/weeks or months, when muscles are weak en balance is not developed yet. In this model, we miss this trauma and the relation between slipping and OCD.

Second, more farms can be participated in the investigation. With more farms, there are more participating animals and a greater difference in the way of housing. We collected a few farms, with a great difference between exercise, but all stables had a deep litter floor at the stable. Maybe OCD will decrease when the foals have 24 hours/day a pasture and no stable. Then the blood flow in the cartilage will increase and muscles are stronger as a result of frequent exercise. With stronger muscles, the sliding risk en thus trauma will decrease. The moving space and exercise between the farms was a great difference. In the low risk farms, foals had a moving space for 24 hours/day against a few hours/dag at high risk farms. According to the investigation of Van Weeren and Barneveld, 1999 the blood flow to the developing cartilage is important. With more blood flow, there is less development of OCD.

Third, we can approve the recording equipment in our investigation. The lying and thus standing up of foals are more frequent at night. In our investigation it was possible to record at night with a minimum of light. But some images remained difficult to see because we used black-white surveillance cameras. With infra-red cameras the images are clear and better to judge.

5. Conclusion

There is more and more evidence that environmental factors are more likely as initial step in the pathogenesis of OCD. There was a significant relation between farms and the sliding ratio. So, management factors are important in the prevalence of sliding. However the results of the prevalence of OCD and the sliding ratio in this investigation are not significant, it is an indication for further investigation. There was a difference between OCD prevalence and high risk and low risk farms at the age of 5 months en 12 months, but it wasn't significant. A challenging though would be to examine this relation with a greater number of foals whether significance would be found.

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