

Results of the Interdisciplinary Research Project on Osteochondrosis Dessicans (OCD)



[BY **DR. LUDWIG CHRISTMANN**]

The interdisciplinary research project on Osteochondrosis Dessicans (OCD) in horses is completed. The estimated time frame of about three years was exactly observed. The research project was a true challenge for all participants. It received great consideration, even internationally. In the end it presents answers to many questions regarding OCD, but not only did it answer questions, it also brought up new questions that must be handled.

The following pages summarize the majority of results. In a future article, we will publish the results about feeding programs in Hannover that deal with the correlation between OCD and the feeding program.

Dr. Ludwig Christmann
Deputy Breeding Manager, VhW



RADIOGRAPHIC EVIDENCE – *The most obvious radiographic signs of OCD are free floating joint matter, resulting from partial separation of a piece of cartilage.*

A Challenge

THE INTERDISCIPLINARY CHARACTER was a special feature of the project. Three different universities with a total of four institutes participated to shed light on the problem of OCD from different angles, and especially provided the opportunity to separate environmental influences from genetic dispositions.

This project delivered a mountain of facts, dates and information – enough material for ten dissertations. The leader of the project was Dr. Erich Bruns from the University Göttingen. He not only provided

proof of his already renowned qualities as an expert, but also of his management qualities, and he never lost focus even in difficult situations of which there were many.

Eighty-three breeding farms participated in the analysis. In the beginning they provided an inventory of 700 foals with dams. An essential selection criterion was the number of foals per farm (a minimum of five). A comparison within a herd was only possible on bigger farms. I would like to express our sincere gratitude to all ▶

WHAT IS OCD?

Osteochondrosis Dessicans is the result of a disorder of the ossification of the growing cartilage. The most obvious radiographic signs are free floating joint matter, resulting from partial separation of a piece of cartilage. These fragments ossify and form the chips.

participating breeders at this point. Not only did they make their valuable horses available, but also the time spent was enormous. Every four weeks the teams of doctorate degree candidates showed up. The foals were weighed, measured and sometimes videotaped (the interpretation of the videotapes was, however, not very useful). Blood was pulled, feed samples were analyzed, the operation's management was recorded, and at the end, the mares and the offspring were x-rayed. The Hanoverian breeders supported the project wholeheartedly, the graduate students were greeted with open arms, and according to the tradition in Lower-Saxony, were given plenty of hospitality.

AROUND THE CLOCK

For the doctorate candidates this was also not an easy task. During the time when the

data was collected – from spring until late fall – two teams were on the road almost around the clock. The team members now really know their way around Lower-Saxony! They also encountered difficulties, for instance the foot and mouth disease in 2001, which made collecting data almost impossible, but the problem was solved. In 2003, however, the problem arose again, this time when the now two-year-olds had to be x-rayed again.

EXPERIENCES

Financing the project presented another great challenge. We encountered major disappointments, but also had many positive experiences. It was especially disappointing that we received no state or federal funds. The positive experiences included all the private donations from Germany and abroad, and the broad support of all

German riding horse associations, which in the end financed the project. Quite a number of breeders, businesses and organizations even made considerable contributions. Volkswagen and Toyota Germany generously supplied high-quality vehicles at no charge for the collection of data. The breed division of the German Equestrian Federation, under the supervision of Dr. Klaus Miesner, proved to be extremely cooperative. Not only did they contribute a considerable amount of money, but also with their help we were able to get the support for the project from other German associations, which meant that we were able to collect more funds. A list of all the supporters appears on page 29. With respect to the results, the project helped us to progress quite a bit. Its concept was built upon the results from previous research projects. We now know more about the frequency of OCD in our horses. We also know more about causes and relations of this developmental disorder. The project proved that several factors have an impact, whereby genetics as well as the environment play a role. Furthermore we opened doors for additional research by including molecular genetics in the project. ▶



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THE BOTTOM LINE – *keeping more of our young horses healthy. The information gained from this project will most certainly impact the decisions breeders and veterinarians make in their approach to the prevention and treatment of OCD.*



INTERESTING HOCK JOINT FINDINGS – A comparison of the findings in foals and in two-year-olds shows that the frequency of findings in the fetlock joint and in the stifle joint greatly decreased. However, in the hock joint the frequency remained almost the same. Often here the early stages developed into OCD lesions.

Dynamic Developments

Radiographic findings constituted the basis for the interpretation but also for other tasks of the interdisciplinary research project on OCD. Graduate students Natalie Krekeler, May Reininghaus and Patricia Arnan from the Free University Berlin conducted the radiographic examinations under the guidance of Prof. Bodo Hertsch.

THE EXAMINATIONS CONSISTED OF TWO parts. The first part took place in the late summer and fall of 2001. Radiographs were taken of 624 foals between five and eight months of age and their mothers. The following joints were x-rayed:

- Fetlock, all four legs
- Both hocks
- Both stifles

In addition, Vera Welcker evaluated the radiographic findings of the sires.

It became apparent that there were so-called early forms visible in a number of foals. It was unclear whether these changes would develop into an osteochondrosis. The original plan was changed. It was decided to re-x-ray these horses at the age of two. The problem: because of sale, loss, etc., not all horses were still available at that age to be reevaluated.

Nevertheless almost two-thirds, a total of 405 horses, were re-x-rayed.

Chart 1 shows the results at foal age. The most findings were present in the fetlock joint (21%) followed by hock (13.1%) and the stifle (6.6%). Only the early stages of OCD changes could be located in the stifles of any of the foals, no free-floating joint matter had yet formed. In the other two joints the figures include the early stages as well as actual formed OCD lesions.

CHART 1 RADIOGRAPHIC FINDINGS (Krekeler, Reininghaus 2003)		
	Mares n= 596	Foals n=624
Fetlock Joint	52 8.7%	131 21.0%
Hock Joint	60 10.1%	82 13.1%
Stifle Joint	7 1.2%	41 6.6%

DIFFERENT CAUSES

The findings in the fetlock joint were reason for serious discussions. In total, bony fragments were documented in five different places. The causes can be very different. Only the lesions at one of these locations (dorsal to the distal end of the cannon bone) are considered to be OCD. Lesions at the other locations are very often caused by trauma.

Only three percent of foals showed OCD lesions in the fetlock and in the hock joint simultaneously. In the majority of cases only one joint was affected.

A comparison of the findings in foals and in two-year-olds (Chart 2) shows that the frequency of findings in the fetlock joint and in the stifle joint greatly decreased. However, in the hock joint the frequency remained almost the same. Often here the early stages developed into OCD lesions, while in the stifle joint only a very few early stages progressed into OCD.

In the fetlock joint we found quite a bit more movement. In 46 percent of the ▶

CHART 2 FREQUENCY OF OCD IN FOALS AND THEN IN TWO-YEAR-OLDS (N=405) (Arnan 2004)				
Positive Findings	Number of Foals	% of n	Number of Two-Year-Olds	% of n
OCD Fetlock Joint	79	19.5%	67	16.6%
OCD Hock Joint	45	11.1%	42	10.4%
OCD Stifle Joint	29	7.2%	9	2.2%

foals that showed changes, as two-year-olds the fetlocks showed no findings. With respect to the fetlock joint, the examinations as foals and as two-year-olds had the identical result in 87 percent, whereas for the hock joint 96 percent had the same result and for the stifle joint 94 percent.

These results clearly reflect that the radiographic examination of foals does not present a 100 percent accurate statement.

Only three percent of foals showed OCD lesions in the fetlock and in the hock joint simultaneously. In the majority of cases only one joint was affected.

It appears that the developmental changes especially in the fetlock joint are relatively dynamic: findings in foals can decrease and disappear completely. With respect to the hock joint the result was very similar; in only a very few cases we found free-floating joint matter in two-year-olds. The radiographs of the hock joint in foals, however, presented the most accurate statement. ▶

OUR SINCERE GRATITUDE TO ALL SPONSORS OF THE INTERDISCIPLINARY RESEARCH PROJECT ON OCD

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- Zuchtverband fuer deutsche Pferde, Verden
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THE TOTAL EXERCISE WITHIN THE FIRST FOUR MONTHS IN A FOAL'S LIFE proved to be very important with respect to the occurrence of OCD. Foals that enjoyed turn-out during their first months often and for long periods of time, showed significantly less osteochondrosis in the fetlock joint. Here, EM Ladylike (Loredo-Ginger/Graphit), owned by Linda Hackney, and her two-day-old 2003 filly by Batido enjoy a first romp together in their pasture.

Exercise is Most Important

In addition to the feeding program, other environmental factors may influence OCD. Exercise is one of them, but there is also the intensity of growth, which is at least partially influenced by the feeding program. Annette Wilke researched how influential growth and exercise are on the occurrence of osteochondrosis in foals.

THE GROWTH DEVELOPMENT IN FOALS is very interesting: every breeder knows how quickly foals grow and change. The matter-of-fact numbers are also quite interesting. During the study foals gained on an average 160 kg (352 lbs.) between the 15th and the

165th day of their lives, and grew an average of 26 centimeters (10.14 inches). The birth weight of 60 kg (132 lbs.) increased to four times as much. During the first weeks, the foals gained about 1300 grams (52 oz.) per day, at six months only 850 grams (34 oz.).

CHART 1 MEAN AND STANDARD DEVIATION OF WEIGHT AND HEIGHT OF FOALS IN FIRST SIX MONTHS OF LIFE (N=694) (Wilke 2003)				
Month	Weight (kg) Mean	Standard Deviation	Mean	Height (cm) Standard Deviation
1	80.6	16.1	108.7	4.6
2	120.8	18.4	117.0	4.3
3	156.0	20.2	123.4	4.1
4	188.0	22.3	128.1	3.9
5	216.1	23.9	132.0	3.9
6	240.0	25.9	135.0	4.0

The sex of the foal plays an important role with respect to growth. As of the third or fourth month, a colt is significantly heavier or taller as the case may be than fillies. Other factors also influence the growth. We focused here not only on the feeding program, but also the general management, the worming schedule and the other factors that may play a role, as well as the age of the dam.

SURPRISE

The correlations between the growth of the foal, expressed in the development of weight and size, and the occurrence of OCD was surprising. Lighter foals showed significantly more osteochondrosis in the fetlock joints than heavier foals. The weight did not, however, appear to influence osteochondrosis in the hock joint, but the height did. Taller foals were more often affected in the hock joint.

The evaluation of these results is not easy. We were unable to explain the reasons for these differences. Does the sex play a role, since colts become heavier at a certain age than fillies, as shown, or are the weight and the size independent from the sex influential?

Exercise from very early on proved to play a significant role in the development of osteochondrosis. According to the specifications of the farm managers, they kept a chart for every foal, which showed how often and for how long every foal had the possibility to go out and move freely. Three terms were derived:

- The **frequency** of exercise describes how often horses had the opportunity to go out and move freely within a certain time frame.
- The **duration** of the exercise portrays the allowed time to move freely.
- The **exercise in total** results from the frequency and the duration within a certain time frame.

The frequency of exercise and the exercise in total greatly depend on the actual birth date, which is not surprising. For instance, in the winter the weather is often bad, the grounds are not horse friendly, often muddy or icy. The result is ▶

that the horses are not turned out. The weather conditions are usually much more favorable when foals are born later. Therefore they often get to go out in pasture during their very first weeks.

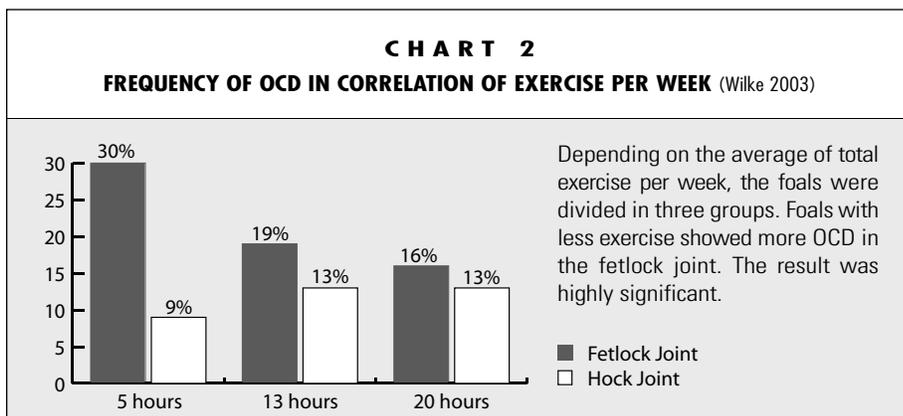
In the research project, foals were divided into two groups: early born foals, meaning born before April 1, and late born foals, born after March 31. The total exercise within the first four months in a foal's life proved to be very important with respect to the occurrence of OCD. Foals that enjoyed turn-out during their first months often and for long periods of time, showed significantly less osteochondrosis in the fetlock joint. A correlation could not be found with respect to findings in the hock joint. Accordingly, early born foals showed significantly more osteochondrosis in the fetlock joint than later born foals.

The conclusion from these results is obvious: horses are moving animals. For a healthy development, movement from the earliest time on is imperative.

In a different area of the project, it was impressively confirmed that the exercise of a young foal strongly influences the bone metabolism. Sarah Winkelsett, of the Institute for Animal Nutrition at the Veterinary University Hannover, researched the concentration of bone building and bone disintegrating factors in the blood of foals. She discovered a significant difference between early and late born foals. She attributed her findings to the fact that early born foals had less movement while having a relatively high supply of energy and protein.

MOVING ANIMALS

The conclusion from these results is obvious: horses are moving animals. For a healthy development, movement from the earliest time on is imperative. It is especially important to allow the foal to run freely, regularly and for long enough periods of time. When foals are locked up in a stall for several days, the movement is blocked. Once the foals are turned out they run and romp excessively. The unprepared joints are at that moment exposed to tremendous stress, which could have a negative impact on ▶



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the cartilage tissue. During longer periods of turnout, which would be the best, the foal moves constantly and the cartilage tissue is permanently exercised. The stress on the limbs of these foals is without risk.

There will always be early born foals, but every breeder must think twice if he takes his mare to a stallion in January. These foals will be born in December, a most unfavorable time with respect to the movement of the foal for the following weeks.

When foals are locked up in a stall for several days, the movement is blocked. Once the foals are turned out they run and romp excessively. The unprepared joints are at that moment exposed to tremendous stress, which could have a negative impact on the cartilage tissue.

It appears to be a useful investment for every breeder to build a large enough paddock that allows foals and their dams to move around freely. There are certain regions in the Hannover breeding area where it is hard to build a paddock with good footing. It is, however, a good investment to secure the footing if one keeps in mind the economical loss that developmental disorders like OCD create.

In many facilities the size of the box stall for the dam and foal was insufficient. Two facilities offered so-called moving stalls (at least 12.5 square meters or 14.95 square yards) that offer a lot of freedom to move.

The results are reason to question the customary way of keeping broodmares in individual stalls. It would be more favorable to keep them in larger areas, and if necessary, in groups as long as mares and foals have turnout available to them at all times. Keeping horses this way could be more financially interesting than the traditional way of keeping them in individual stalls. However, it requires careful management including constant supervision. It would certainly be interesting to find out if such a way of keeping horses is possible when breeding sport horses.



HERITABILITY – The results show that the heritability of osteochondrosis lies within an area that a breeder can influence through careful selection. **Above:** EM Saoanjul (Sao Paulo-SPS Goldjulchen/Goldfinger) owned by Elizabeth Schump and bred by Dieter Wolff, with her foal by Rabino.

Trends in Heritability

Is OCD hereditary, if so, how high is the heritability? Is it even possible to locate the genes that are responsible? Two different institutes dealt with these questions: Mirja Schober at the University of Göttingen, Institute of Animal Breeding and Genetics, of the team of Prof. Erich Bruns, calculated genetic parameters, whereas Katrin Löring, under the guidance of Prof. Ottmar Distl, University of Hannover, Institute of Animal Breeding and Genetics, analyzed the genome to find genetic markers.

THE DETERMINATION OF HERITABILITY was conducted with the use of a complex computer program. Similar to the breed value estimation, a BLUP-animal design was applied. This means that all related animals (parents, siblings, half-siblings) are being included. Furthermore, this design is capable of including environmental influences, so-called fixed effects. With respect hereto, the interdisciplinary concept of this research project proved especially valuable. During the early stages of the project, other components (influences of sex, movement, feeding) determined in so-called variance analyses that those environmental influences had significant impact on the occurrence of OCD.

To find the suitable statistical model there were some experiments since it had to be differentiated between age groups:

foals, two-year-olds and dams. The chart on page 33 shows different designs and for which group of horses they were used.

A difficulty presented itself in the fact that the findings on the radiographs were not linear characteristics but so-called binary facts, which only state if there is a finding or not. Therefore the simulated values were transformed according to Dempster and Lerner (1950). The following results are based on the transformed values.

The estimated heritability varied according to the applied arithmetical design. For the fetlock joint the values were mostly between 10 and 20 percent, for the hock joint the degree of heritability was twice as high.

No estimations were done with respect to the stifle, since the frequency of the findings was too low. The extent of the ▶

findings for the estimated values is comparable to those for conformation traits. The estimated values for the findings in the hock joints are clearly higher than for the findings in the fetlock joint, which leads to the belief that the fetlock is more influenced by the environment. A very interesting comparison between the offspring of mares with and without osteochondrosis supports this statement.

With respect hereto, the following conclusion was quite obvious: out of 61 mares with OCD in the hock joint, 27.9 percent of the offspring showed positive results, while positive findings were detected in only 11.7 percent of the descendents of mares without OCD.

The radiographic evidence proved that horses either had findings in the fetlock or hock joint, but hardly ever in both joints at the same time.

A similar tendency was visible in the findings of the fetlock joints; however, this tendency is not as secured statistically. Fifty mares had osteochondrosis in the fetlock joint. Positive findings were diagnosed in 28 percent of their offspring. Out of the mares without findings, a significantly lesser number of descendents, only 19.8 percent, showed osteochondrosis.

Two further evaluations are worth mentioning. It was determined that the findings between the hock joint and the fetlock joint have a strong negative correlation to each other (the genetic correlation is -0.58). The radiographic findings proved that horses either had findings in the fetlock or hock joint, but hardly ever in both joints at the same time.

Other genetic correlations were determined between radiographic findings and conformation and performance attributes. Hereto, breed values of the sire regarding hind leg criteria, correctness of movement, size, as well as dressage and jumping ability were included. The discovered genetic correlations to osteochondrosis were consistently around zero. This reflects that there is no correlation between the appearance of osteochondrosis and the evaluation of conformation. This also reflects that no long-term performance shortcomings are to be expected, for ▶

MODELS FOR THE CALCULATION OF THE HERITABILITY OF OCD

- Calculated by applying the BLUP-animal Model
- Fixed effects
 - Time of Birth >
 - Before/after April 1st } Model I (mares) >
 - Sex
 - Amount of exercise
 - During the first four months
 - Parameters of Nutrition
 - Intake of crude protein, energy and calcium

} Model II (foals, mares two-year-olds)

} Model III (foals)



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instance in dressage or jumping ability, if osteochondrosis would be more strongly incorporated in the selection endeavors.

In the end, these results show that the heritability of osteochondrosis lies within an area that a breeder can influence through careful selection. It appears that different genes control findings in the hock joint and in the fetlock joint. Both joints must be viewed as different traits. As such, they must be incorporated into the selection decisions.

In the end, these results show that the heritability of osteochondrosis lies within an area that a breeder can influence through careful selection.

The Institute for Animal Breeding and Genetics at the Veterinary School Hannover, under the leadership of Prof. Ottmar Distl, followed a different lead to clarify the genetic correlations. Katrin Löring researched the question if gene markers can be identified which have a connection to the presence of OCD. This research project is not quite finished, however, promising preliminary results were obtained which allow us to expect progress in the determination of molecular genetic causes for OCD. Even a development of a gene test is in the realm of possibilities. ■

Dr. Ludwig Christmann studied animal husbandry at the universities of Giessen and Göttingen, completing his studies with a Master's degree in 1981. He received his Doctorate degree in 1996 following a number of years of original research. Dr. Christmann has worked for the Hanoverian Verband since 1984, serving for many years as Deputy Breeding Director. He has made many visits to North America and has been a frequent participant in past inspections and AHS annual meetings. He, his wife and two daughters breed horses on a small scale in Germany.

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**CHART 1
COMPARISON OF FREQUENCY OF OCD IN STIFLE JOINT OF OFFSPRING OF MARES WITH AND WITHOUT OCD (N=591)**

	Number of Mares	Offspring with OCD		Offspring without OCD	
		n	%	n	%
Mares with OCD	61	17	27.9%	44	72.1%
Mares without OCD	530	62	11.7%	468	88.3%

OCD RESULTS AT A GLANCE

Frequency of Findings

- About 30 percent of the examined horses showed positive findings.
- The most findings were in the fetlock joint followed by the hock joint. The stifle joint was hardly affected.
- The value of radiographs from foals with respect to their later use as breeding or sport horses is overall limited and different for the individual joints. Especially the findings in the fetlock joint show great discrepancies between taking the radiographs as a foal and as a two-year-old.

Growth and Sex

- In foals the sex plays a significant role in the frequency of findings. In fillies we found more findings in the fetlock joint, in colts more in the hock joint.
- Starting in the fourth month, lighter foals had more osteochondrosis findings in the fetlock joint.
- Taller foals had significantly more findings in the hock joint than smaller sized foals.

The Influence of Movement

- If foals move around more often and extensively, the frequency of osteochondrosis overall, especially in the fetlock joint, will be significantly reduced. Inadequate movement, which results in irregular and short-term stress on the limbs, is to be avoided.

- Early born foals – born before April 1st – clearly show more osteochondrosis than later born foals, the reason for being that these foals lacked movement during the winter months. This effect was more obvious for the fetlock joint than for the hock joint.

Genetic Parameters

- The degree of heritability for osteochondrosis in the fetlock joint stays in the lower range (between 10 and 20 percent), for osteochondrosis in the hock joint the degree of heritability almost doubles.
- The frequency of findings in the hock joint and the fetlock joint has a negative correlation to each other. In most horses either one or the other joint was affected. This means that we have to view OCD in the fetlock joint and OCD in the hock joint as two separate characteristics.
- There is no genetic correlation between the predisposition for osteochondrosis and the predisposition for dressage and jumping, or for the criteria for the evaluation of the exterior.
- The examination of the molecular genetic correlations with respect to OCD delivered progress. Even the development of genetic testing seems possible.

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