

Feeding to minimize DOD

Nutrition plays a role in developmental orthopedic disease, but the relationship is complex

by Ginger Rich, Ph.D., with Bonnie Kreidler

Developmental orthopedic disease, commonly known as DOD, is a catchall term encompassing joint, bone, and tendon problems that can occur in growing horses, particularly in the first six months of their lives.

DOD includes physitis, osteochondrosis, and *osteochondritis desicans*, which occur when the cartilage at the ends of the animal's long bones fails to change to bone properly. Also falling under the DOD umbrella are: wobbler syndrome, which occurs when the cervical spinal cord is damaged; angular limb deformities, such as enlarged fetlocks or open knees; and contracted tendons. Some researchers add juvenile arthritis to the list.

It can be difficult for breeders and farm managers to get a handle on the best preventive measures to follow. Because DOD includes such a broad constellation of potential problems, there is no single, clear-cut cause or cure for all of them.

Nutrition clearly plays a role. DOD in its various forms has been blamed on too much protein, too little protein, excess calcium, too little calcium or phosphorous, and trace mineral deficiencies. However, nutritional changes alone are not the magic bullet.

Current research points to a combination of microtraumas caused by mechanical stresses to growing joints and excess calories (particularly from carbohydrates), pushing fast growth without the right balance of protein and minerals for proper bone repair and growth.

Besides the types of exercise and nutrition young foals receive, some researchers speculate that a genetic component that includes insulin response and predisposition to rapid growth may also be involved.

Predicting foals at risk

Several population surveys of Standardbred trotters in Scandinavia suggest that the inheritability of certain types of osteochondrosis may be as high as 25% to 50%. A conscious or unconscious bias toward breeding larger, faster-growing horses may be partially responsible for high levels of DOD among racing breeds.

Researchers have targeted several factors as predictors of a foal's likelihood of developing DOD: higher birth weight, early birth month, larger frame, fast growth rate, and male gender.

Joe Pagan, Ph.D., and Stephen G. Jackson, Ph.D., logged the incidence of DOD on a Kentucky Thoroughbred farm over a four-year period in their search for correlations (*World Equine Veterinary Review* 1996; pp. 20-26). They limited their survey to lesions of the fetlock, hock, shoulder, or stifle and found orthopedic problems in 10% of 271 foals they examined.

The researchers first noted visible clinical signs and then confirmed their suspicions by X rays. Fetlock problems tended to become noticeable at approximately six months of age, while hock, shoulder, or stifle problems showed up at ten to 12 months.

Hock, stifle, and shoulder lesions tended to occur in foals that had higher birth weights and rapid growth that kept them above the average Kentucky weight throughout their first year.

Interestingly, foals that developed fetlock problems tended to be early foals of normal weight and size. The researchers speculated that restricted exercise in their early months followed by increased activity as the days grew warmer created biomechanical stresses on otherwise normal cartilage.

Another study (*Journal of Equine Veterinary Science*) surveyed 77 Standardbreds from birth to 16 months of age. The eight foals (four colts and four fillies) that developed radi-

ographic signs of DOD lesions had higher birth weights and larger frames. However, 11 other foals that showed bone fragments or open joints were smaller and had lower average daily weight gains. Again, the researchers concluded that multiple factors were at work in causing various types of DOD.

Farm managers should be aware of possible factors that may put a foal at greater risk for DOD. Foals born in January, February, and March tend to be larger at both birth and maturity than foals born in mid-spring or late spring. Colts grow faster and have larger frames at maturity. Taller, heavier animals are more prone to DOD. Foals are most at risk for developing DOD during the first few months of their lives, which means the nutrition of pregnant or lactating mares is a critical factor in prevention.

Protein and energy

At various times over the past 20 years, both excess protein and excess energy (calories) have been blamed as the cause of DOD. Studies indicate that DOD is associated with fast growth, and certainly excess food energy is a factor that can push fast growth. However, researchers are finding that preventing DOD is not quite as simple as adjusting a single nutritional factor in the diet.

One study (Proceedings on Equine Osteochondrosis in the '90s; 1992) compared a control group of foals fed a diet based on 100% of the National Research Council's recommendations for digestible energy and protein to two other groups. The second group received a diet with 126% of the recommendations for crude protein. The third received 129% of the recommendations for energy. Six out of 12 foals fed the high-energy diet developed clinical and radiographic signs of DOD; at necropsy, 11 of 12 foals had lesions. In contrast, none of the foals on the high-protein or control diets showed any clinical or radiological signs of DOD.

Farm managers should be more concerned about a protein deficiency that limits bone growth or an imbalance between protein and energy levels in the diet than they should be about excess protein.

While a high-protein diet does not increase the risk of DOD, the same cannot be said for low-protein diets. A 1988 Cornell University report found that a low-protein diet (9%) reduced bone remodeling and subsequently reduced cannon bone circumference. The researchers also speculated that a low-protein diet could contribute to angular limb deformities.

Other studies have confirmed a high correlation between high-energy rations and DOD. However, excess calories do not appear to be the sole culprit. Researchers have concluded high energy

Signs of DOD

- Abnormal bumps, bulges, ridges, or swelling around growth plates at the ends of long bones in knees, fetlocks, hocks, or stifles or in shoulders
- Pain or stiffness at any gait but especially the trot
- Lameness that develops over the day
- Lack of normal playfulness in young foals
- Preference for lying down rather than normal activity
- Enlarged knees or fetlocks in young foals

coupled with inadequate protein (either in amount or quality) and insufficient or unbalanced minerals contributes to DOD.

Farm managers should also pay attention to the energy sources in the diets of young, growing horses. Researchers are currently studying the different ways high-carbohydrate diets or fat-supplemented diets can affect bone formation.

Thyroid, growth, insulin, and other hormones affect the maturation process of bone. High-carbohydrate meals affect hormone levels by causing an insulin spike or glycemic response. High-carbohydrate meals may affect levels of other growth hormones as well.

A Kentucky Equine Research study by Pagan (Proceedings of the 2001 Equine Nutrition Conference for Feed Managers) examined weanlings on several Thoroughbred farms to explore whether any correlation existed between the incidence of DOD and the glycemic response of the weanlings to their grain meals.

Overall, 11.5% of the weanlings developed DOD. However, one farm with 24 weanlings had no incidence of DOD while 32% of 19 weanlings at another developed orthopedic problems. Weanlings at the latter farm showed the highest glycemic response. Since there appeared to be a strong correlation between the glycemic index of the feed and the glycemic response of the weanlings, more research needs to be done to determine whether feeding low-glycemic meals could help prevent DOD.

In theory, lowering the glycemic index of a horse's overall diet can be accomplished by reducing or eliminating molasses, reducing the amount of starchy carbohydrates that are digested in the small intestine, increasing the amount of digestible fiber that is processed and absorbed in the hind gut, increasing the amount of fat, or some combination of these.

Substituting digestible fiber such as beet pulp or soybean hulls or such fats as vegetable oil or rice bran for some of the starchy carbohydrates in a youngster's diet must be done with care, how-

ever, so that the protein and mineral content of the total ration does not become unbalanced. Otherwise, foals may take in sufficient calories for growth but insufficient protein and minerals.

A 1999 study in the *Journal of Animal Science* determined that foals on a diet based on fat and fiber rather than starches and sugars showed decreased bone mineralization. The authors speculated that the fat may have decreased calcium absorption. Further research on the best way to develop low-glycemic diets for young growing horses is needed.

Minerals

The importance of sufficient minerals in the right ratios for good bone formation has long been recognized. At various times, high calcium, high phosphorous, low copper, and high zinc have all been implicated in DOD. In one study, researchers fed young horses three times the National Research Council recommendations for calcium without producing DOD. In another study, high levels of phosphorous increased DOD in unexercised foals while high levels of calcium did not unless combined with high levels of digestible energy.

Copper plays an important role as part of an enzyme that links collagen filaments to create the cartilage matrix that will

eventually mineralize into mature bone. Studies dating back to 1949 have shown a link between low copper levels and DOD lesions.

A New Zealand study found that supplementing mares with copper decreased the incidence of DOD in their foals at five months of age but did not totally prevent the disease, thus emphasizing that multiple factors are at work in DOD.

Many nutritionists feel the current recommendations for copper in the diet of young growing horses, ten parts per million, is too low. However, farm managers should be careful not to err on the side of excess copper. Since copper and zinc must be balanced in a ration, either low copper or high zinc can contribute to DOD. Maintaining a 4:1 zinc-to-copper ratio is ideal.

Recommendations

While dietary modifications alone cannot prevent or cure all types of DOD, nutrition obviously plays a key role. Critical nutritional factors at various stages of growth include:

- **Pregnancy.** Nutritional prevention of DOD should start while foals are still in utero. The pregnant mare's diet should contain sufficient calories and protein (THOROUGHBRED TIMES, October 9, 1999). Feed high-quality protein sources such as soybean meal or dried milk products (not cottonseed meal, linseed meal, or corn-gluten meal) that supply essential lysine and the right balance of minerals.
- **Lactation.** During lactation, foals grow rapidly, and the quality and quantity of the mare's milk are critical issues. Continue to feed mares high-quality protein and the proper mineral balance. Once a mare has produced a foal with DOD, analyze her milk for nutrient content. Consider weaning foals of mares whose milk is of low quality or quantity early and either feed them as orphan foals or put them on a nurse mare (THOROUGHBRED TIMES, February 27, 1999).
- **Creep-fed foals.** Evaluate the energy level and mineral content of the total diet. Use high-quality protein sources and provide only enough supplemental feed to support moderate rather than fast growth. Creep feed cautiously to avoid forcing fast growth.

Creep feed should be 16% protein with 0.8% to 1.1% lysine. Provide 0.8% calcium and 0.6% phosphorous. Aim for a calcium-phosphorous ratio of 1.1:1 and never let the ratio get more than 3:1. Provide copper in a ratio with zinc of 1:4. Feed a creep mix that has a minimum of 20 parts per million (ppm) of copper, 80 ppm of zinc, and 80 ppm of manganese.

Suspected causes of DOD

- Genetic predisposition
- Poor broodmare nutrition, particularly in the last trimester
- Mare's milk that is low in quantity or in nutrient quality
- Mare's milk that is excessive in quantity leading to too rapid growth
- Improper calcium-to-phosphorous ratio in overall diet
- Lack of trace minerals, particularly copper, zinc, and manganese, necessary for healthy bone growth
- Excess energy (calories, primarily from carbohydrates) in the diet
- Obesity in growing animals
- Sudden change to enriched energy and nutrient levels for previously underfed youngsters
- Mechanical trauma, excessive joint compression due to forced exercise, or lack of exercise
- Lack of exercise for very young foals
- Forced exercise for older foals
- External trauma such as a kick or fall leading to compression or fragments within joints
- Excessively hard footing

An exercise connection

Researchers believe that stressing the bones of young, growing horses through exercise creates tiny microfractures in those bones. As the body lays down new mineral-rich tissue to repair these microscopic fractures, the bone is thickened and remodeled. Frequent exercise at a consistent stress level produces strong, hard bones. When exercise is infrequent or the stress level varies from almost none to a high level, the result is injury or irregular growth patterns.

The challenge is to provide nutrition that supports growth while providing exercise that stresses bones enough to create dense, hard bone without causing injury. Confining sucklings and their dams to stalls or small runs does not allow the foal's growing skeleton sufficient opportunity for exercise stress.

Keeping weanlings or yearlings in stalls with only an hour or two of daily exercise similarly puts them at risk for orthopedic problems. This is especially true when available turnout areas have hard footing or their exercise consists only of forced walking and trotting. Ideally, weanlings should be housed in same sex groups in pastures large enough for them to run and play at will. Rolling terrain that further challenges young bones is even better.

One study on Warmblood foals suggests that exercise may prevent youngsters that already have DOD from becoming worse. Forty-three foals with DOD were divided into three groups. One group was pastured, another was kept in box stalls, and the third was kept in box stalls but given an increasing number of daily gallops.

After weaning at five months, half of the foals in each group were euthanized, and the remaining foals were given identical light exercise for another six months. The researchers found that the foals kept in box stalls had the most severe lesions at both five and 11 months. Surprisingly, at 11 months, the number of lesions had significantly decreased.-Ginger Rich, Ph.D., and Bonnie Kreitler. ■

That translates to 8 milligrams (mg) of copper, 24 mg of zinc, and 24 mg of manganese per pound of creep feed.

Start at the rate of one-quarter pound creep feed daily at around two months and gradually introduce another quarter-pound as the foal cleans up its feed. As the amount the foal eats reaches one pound, divide it into two daily meals. Limit creep feed to 0.75 to 1.0 pound of creep per 100 pounds of body weight daily.

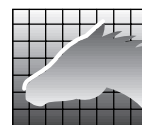
- Weanlings. Continue to evaluate the energy level and mineral content of the total diet and aim for moderate growth. The four- to six-month-old weanling needs 3% of its body weight daily in feed from grain, high-quality hay, or free-choice pasture. Grain should be limited to 1 to 1.5 pounds per 100 pounds of body weight daily of a 14% to 16% crude protein grain mix depending on forage (see table, page 24). Avoid feeding energy in excess of foal's needs for normal growth. Since grass forages are low in lysine, the high-quality protein concentrates in the weanling's diet should have 0.8% to 1.10% lysine to bring the level of lysine in the total diet to 0.65%. Make changes in feed types or amounts gradually to avoid pushing fast growth.

If current research holds true, farm managers may soon be able to take a single blood sample from a weanling to determine the glycemic response of that individual to its feedstuffs, adjust the nutritional mix for that young horse, and better manage the incidence of DOD. While research is far from complete, the theory that DOD may be reduced by feeding a low glycemic diet to weanlings holds promise.

Use weight tapes or livestock scales to chart foal weight and growth accurately. On average, foals gain two to three pounds daily during their first six months. However, it is not unusual to see a Thoroughbred born big-boned and ribby gain as much as four to five pounds daily in its first few weeks. Daily weight gains also tend to rise as the mare reaches peak lactation at six to eight weeks.

Equine health professionals and farm managers agree that daily weight gain is not as important as a steady growth curve. They observe that foals with steady growth are less likely to develop DOD than foals whose growth bounces from peak to valley or plateaus and then spurts. The best way to keep foals growing consistently and to catch problems before they go too far is to weigh foals twice monthly. ■

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