

# Developmental orthopedic disease in large-breed puppies

Rapid growth can rapidly lead to skeletal abnormalities. Here's how a careful look at a pup's nutrition can help.



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In dogs, osteochondritis is one of a diverse group of developmental orthopedic diseases (DODs) that occur in young growing animals, most commonly fast-growing large- and giant-breed dogs (e.g., Rottweilers, golden retrievers, Great Danes, Newfoundlands, Saint Bernards).

Osteochondrosis in dogs is noted as a disruption in endochondral ossification that results in a focal lesion. (1) It occurs in the physis or epiphysis of growth cartilage. When it occurs in physeal cartilage, it may cause growth abnormalities such as angular limb deformities in long bones. Osteochondrosis of the articular epiphyseal cartilage commonly occurs in the shoulder, stifle, hock and elbow.

Acute inflammatory joint disease may occur subsequent to osteochondrosis when the cartilage is disrupted and subchondral bone is exposed to synovial fluid. Inflammatory mediators and cartilage fragments are released into the joint, perpetuating the cycle of degenerative joint disease. The most critical period for the initiation of DOD occurs during early bone growth, before physeal closure. During this period (the first 12 months of life), the skeletal system is most susceptible to physical, nutritional and metabolic insults because of increased metabolic activity. Large and giant breeds are most susceptible because of their genetic potential for rapid growth. Familial history is an important predisposing factor for DOD in dogs. (1)

## **Nutrition as a factor**

Studies (2-11) have discussed risk factors linked to an increased risk of DOD, osteochondrosis and osteochondritis dissecans (OCD) in dogs, with males being at higher risk for developing OCD in the shoulder joint. Nutritional factors include free-choice feeding or overfeeding (especially high-energy foods linked to rapid growth), excessive calcium intake, excessive mineral intake at a young age and an imbalance of vitamin D metabolites. High-energy diets can promote increased concentrations of growth hormone, insulin-like growth factor (1), triiodothyronine, thyroxine and insulin.

Nutrients must be given in appropriate amounts and be balanced for optimal bone development. Excessive calcium and energy, together with rapid growth, appear to predispose dogs to osteochondrosis. The detrimental influence of excess energy intake on skeletal development during growth has been demonstrated in dogs. When the bones of overweight, growing, large- and giant-breed dogs experience increased weight load (static forces) and muscle pull (dynamic forces), their immature skeletons may be damaged. (1)

“For large-breed puppies, over nutrition or rapid growth—with weight more than height—along with excess calcium and genetics are the primary risk factors for DOD,” says Dana Hutchinson, DVM, DACVN, veterinary nutritionist and

a manager of veterinary affairs at Hill's Pet Nutrition. Great Dane puppies given a diet high in energy and minerals free choice (6) or high in calcium alone (8) developed osteochondrosis lesions with overt clinical signs of disease.

Large-breed dogs raised on food with a high calcium content or both a high calcium and phosphorus content retained cartilaginous cores in the distal radius and ulna, (9) had disturbed endochondral ossification (12) and experienced delayed skeletal maturation and growth of bone length. (13) Calcium seems to be an important determining factor in DOD.

The risk of DOD appears to be increased in large- and giant-breed puppies fed highly palatable, energy-dense foods free choice, even if foods are well-balanced. One study noted that if free-choice feeding is used, it should be done only in combination with a low energy-density food to decrease the risk of DOD and obesity. (14) Generally, free-choice feeding is risky and not recommended for such puppies until they've attained adulthood. (1)

In dogs fed a low-calcium diet, absorption can increase to greater than 80 percent, and in dogs raised on a diet with excessive calcium content, calcium retention increases proportionally. Feeding within the limits of the calcium: phosphorus ratio is not as important of a long-term influence on calcium absorption and retention as is the calcium content per se in the diet in young, rapidly growing dogs. (15)

In studies thus far, the differences in protein intake have not been shown to affect the occurrence of disturbed skeletal development in young Great Danes, and an etiologic role for dietary protein in the development of osteochondrosis in dogs is unlikely. (16)

Thus, large and giant breeds are the most susceptible to skeletal disease, and genetics, environment and nutrition play key roles. (17) Nutritionally, the rate of growth, feed consumption, specific nutrients and feeding methods influence our ability to optimize skeletal development and minimize skeletal disease. In addition, the growth phase of 3 to 8 months, and possibly the phase prior to weaning, are integral to ultimate skeletal integrity, although a large-breed growth diet is critical until these puppies have reached adult size—an age approaching 18 months of age for many large-breed dogs. Giant breeds may be limited in their ability to cope with excessive minerals such as calcium, and the results are abnormal bone remodeling and skeletal disorders.

### **How controlling the diet can help**

To deal with skeletal disease in these breeds, nutritional management alone won't be sufficient to manage developmental bone diseases. But we can help prevent some skeletal diseases by appropriately feeding diets with optimized nutrients. Dietary deficiencies are of minimal concern in this age of commercial diets that are specifically prepared for young, growing dogs. Rather, the potential for harm is in over nutrition from excess consumption and supplementation.

Growing giant-breed dogs are more susceptible to developing skeletal disorders than small-breed dogs when raised on a diet with deficient or excessive calcium content. Even at an optimal calcium intake, giant-breed dogs have more irregular growth plates with manifestation of moderate disorders of endochondral ossification than smaller breeds.

This phenomenon may be related to differential regulation of calcium homeostasis and skeletal growth between breeds. Giant breeds grow rapidly, and high plasma concentrations of growth-regulating factors—which in turn may influence vitamin D3 metabolism (whereby 1,25-dihydroxycholecalciferol is favored over 24,25-

dihydroxycholecalciferol)—may be a pathophysiological factor responsible for the increased incidence of skeletal disorders, in addition to the potential growth factors and calcitonin. It remains to be elucidated whether vitamin D3 supplementation would facilitate optimal growth in giant-breed dogs. (18)

To help prevent the disease, it's critical to control dogs' growth to the best of our abilities through feeding the amount of calories needed to keep them in a lean body condition while they're growing by using a growth formula designed for large breeds, Hutchinson says. "To accomplish this body condition, meal feeding rather than free feeding is also pivotal," she says. "The goal is optimal body condition, not maximal body condition. The formulas are an important starting point, but the individual dog needs to be considered in these cases. To control rapid growth as much as possible, we need to feed for optimal body condition." She recommended a body condition score of 2.5 to 3, rather than 3 to 3.5, using the five-point system.

Because we need to carefully regulate large- and giant-breed puppies' caloric intake while they're growing, it's important they be fed an appropriate diet—one that's not extremely high in calories and doesn't promote overfeeding by owners. If the volume of an energy-dense growth diet is restricted, it may result in deficiencies in other nutrients. "Many of the super-premium diets on the market today fall into this category of highly energy-dense dog food," Hutchinson says.

Large-breed puppy formulas, on the other hand, have a reduced caloric density and reduced calcium and phosphorus compared with other growth diets for dogs. "An optimal diet for a large-breed puppy is one that is designed specifically to meet the nutrient requirements for growth of large breeds, contains an appropriately controlled caloric density needed by these puppies to avoid rapid growth, and has the proper calcium, phosphorus and vitamin D content, as well as calcium: phosphorus ratio," Hutchinson says.

### **Finding the right balance of calcium, phosphorus and vitamin D**

When calcium, phosphorus and vitamin D aren't in the appropriate concentrations in the diet, this is also a risk factor for DOD. "This is why it's dangerous to switch these puppies to an adult diet at a young age as a means of controlling their growth," Hutchinson says. "The caloric density of the diet ends up necessitating intake of such a large volume of food that they end up taking in excess levels of other nutrients, some of which, when fed in excess, have their own risk factors for DOD.

"That is, switching to an adult food to avoid excess calcium may actually result in the puppy receiving as much or more calcium than if fed a growth diet because of the low calorie density," she continues. "A diet formulated for large-breed puppies is our way of avoiding these issues."

By recommending a transition to an adult maintenance diet for a growing puppy, large-breed or otherwise, all the differences in nutrient requirements between adults and puppies are ignored, such as increased requirements for calcium, phosphorus, iron and protein, just to name a few, Hutchinson says. Large-breed puppies grow until 18 months of age, so they should be on a growth diet designed for them until they're 90 to 99 percent grown.

"While we often worry about excess calcium in these dogs, some studies have also shown they're more sensitive to the impact of calcium deficiency, as well," she continues. "So it's critical they receive the appropriate levels of these key nutrients during growth. Excess calcium and/or vitamin D have been shown to be a risk factor for DOD, but due to its inseparable role in calcium and vitamin D metabolism, appropriate phosphorus intake is also important."

Far fewer studies have been done that look at the impact of phosphorus specifically. “When we do see an imbalance of phosphorus, it’s usually in puppies fed a raw diet. And the diets are usually high in phosphorus and low in calcium, predisposing the puppies to nutritional hyperparathyroidism,” Hutchinson explains. Puppies are less capable of adapting to not only nutrient deficiencies but also nutrient excesses.

“This is just one example where it can have a devastating impact, and another reason why the often-unbalanced raw diets and homemade diets are dangerous,” Hutchinson says. The calcium, vitamin D and phosphorus concentrations are very important, but the calcium: phosphorus ratio is also important and has been studied in growing large-breed puppies.

“We know that while other puppies tolerate a relatively wide range in calcium: phosphorus ratios from 1:1 to 2:1 without an increased risk of DOD, in large-breed puppies it needs to be on the lower end of that range,” Hutchinson continues. “Large-breed puppy diets are designed to avoid excess calories while providing defined, appropriate levels of calcium, vitamin D and phosphorus. Owners of large-breed puppies should avoid multivitamin supplements and top dressings to avoid providing excess, since these diets provide all the nutrients the puppies need. If an owner feels the need to add to a puppy’s diet, I suggest adding fresh, no starchy vegetables without added fat, sodium or other flavorings.”

Like many areas of medicine, however, there’s still a great deal of research and debate over what the most ideal nutrient levels are for large-breed puppies, Hutchinson says.

### **Other minerals**

Even less research is available on other minerals that can impact the incidence of DOD in puppies. Copper is important during growth because of its role in collagen and elastin metabolism. “But is it any more important in large breeds than in any growing animal? Not that we know of,” Hutchinson says.

Zinc is also important in all growing animals because of its role in connective tissue metabolism and its necessity for skeletal growth. “To my knowledge, it’s no more important for large-breed puppies, however,” Hutchinson says. “There are a few breeds with inherited disorders of zinc metabolism, such as in some lines of Bull Terriers and Alaskan Malamutes. So in puppies with those diseases, of course, it is of even greater concern.”

### **The research continues**

What’s most known about development of skeletal disease in young growing dogs is in the area of caloric intake, body condition and calcium and phosphorus intake. “Though there’s more known in the area of other minerals’ roles in DOD in horses,” Hutchinson says, “comparable research in many of those areas is just not available in dogs.”

Also, the relationship of genetics has not been fully explored in large- and giant-breed dogs up to this time. Maybe such genetic puzzles will eventually be disclosed?