Epidemiology of osteoarthritis

Esteban Mele, DVM

Surgery Department, School of Veterinary Sciences, University of Buenos Aires, Argentina

Dr. Mele graduated from the School of Veterinary Sciences at the University of Buenos Aires. In 1999, he obtained a degree of Specialist in Canine and Feline Clinical Medicine. He is a surgeon and Professor in the Surgery Department, School of Veterinary Sciences, University of Buenos Aires and a researcher at the Institute of Basic Sciences and Experimental Medicine of the Italian Hospital of Buenos Aires. He specialized in Orthopedics, and is an Alumni member of AO/ASIF. He is the creator and director of the MIAT Course (Initial Management of the Traumatized Animal), included in the Latin American Trauma Program (MIAT-RABAP). Dr. Mele is also member of the Latin American society for Emergentology.

KEY POINTS

- Developmental orthopedic diseases and associated osteoarthritis are the most common articular diseases in dogs
- Secondary OA is clearly the most common joint disease affecting both dogs and cats
- Overfeeding growing puppies results in a more rapid growth, which may cause osteoarthritis
- Cranial cruciate ligament rupture is the most common cause of lameness, pain and osteoarthritis in dogs

Osteoarthritis (OA) is a slowly-progressive degenerative joint disease characterized by a loss of joint cartilage and the subsequent exposure of subchondral bone (1). This eventually results in a self-perpetuating insidious disorder characterized by joint pain. New bone formation occurs in response to the chronic inflammation, and local tissue damage in an attempt to limit both movement and pain. Macroscopically, there is loss of joint cartilage, a narrowing of the joint space, sclerosis of subchondral bone, and the production of joint osteophytes (2) ***(Figure 1)***.

OA is the most common arthropathy in man and animals, being more frequent in dogs than in cats. In humans, the prevalence in women is two-fold higher than in men, and its incidence increases after 60 years of age (3). In dogs, the onset of primary OA depends on breed. The onset mean age is 3.5 years in Rottweilers and 9.5 years in Poodles (4).

The developmental orthopedic diseases and associated osteoarthritis are the most common articular diseases in dogs. They account for some 70% of visits for articular disease and related problems within the appendicular skeleton. Twenty two percent of cases were dogs aged one year or under (5). The incidence of OA is increased by trauma as well as obesity, aging and genetic abnormalities.

Risk factors in canine osteoarthritis

Signalment

- ***Age:*** >50% of arthritis cases are observed in dogs aged between 8-13 years. The musculoskeletal diseases are very common in geriatric patients, and nearly 20% of elderly dogs show orthopedic disorders. In Labrador Retrievers aged >8 years, OA in several joints (elbow, shoulder, hip, knee) is typical
- ***Sex:*** In general, OA is often associated with primary disorders, which may be more prevalent in males than in females. For example, the fragmentation of the coronoid process is observed in a 3:1 male: female ratio
- ***Size:*** 45% of dogs with arthritis are large breed dogs. Among these, >50% are giant breed dogs, while only 28% are medium breed dogs and 27% are small breed dogs.

Figure 1. Coxofemoral joint osteophytes.

Obesity

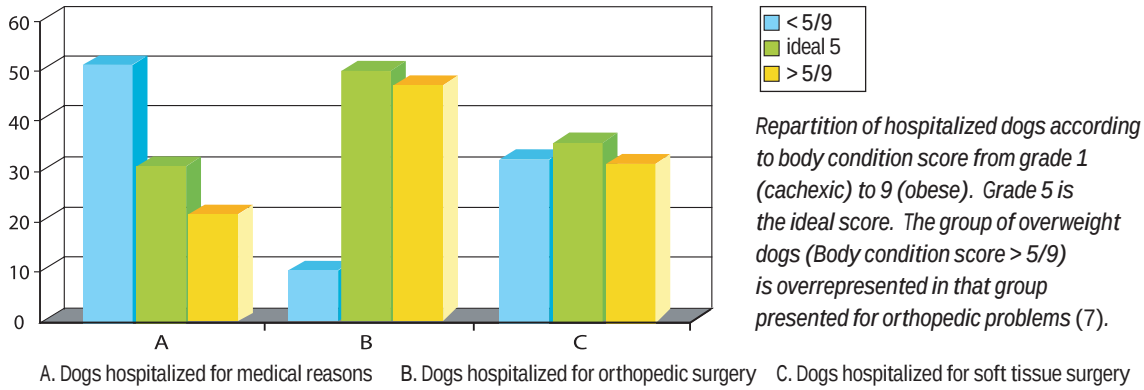
Figure 2 illustrates the relationship between body condition score and hospital admissions for orthopedic disorders. In puppies, obesity and overfeeding have been associated with the onset of joint diseases, particularly hip dysplasia (6).

Osteoarticular trauma

Joint surgery (*e.g.*, intra-articular stifle surgery) stimulates the onset of arthritis. Although long term studies are still required, the publications available to date indicate that the tibial plateau leveling osteotomy for the treatment of cruciate ligament ruptures minimizes OA progression, compared to other surgical corrections ***(Figure 3)***. Vigorous exercise, particularly during growth, also has been recognized as a predisposing factor.

Genetic predisposition

Certain breeds, such as the Labrador Retriever and the German Shepherd dog are predisposed to develop arthritis, over and above the prevalence of underlying joint disease in these breeds.



Repartition of hospitalized dogs according to body condition score from grade 1 (cachexic) to 9 (obese). Grade 5 is the ideal score. The group of overweight dogs (Body condition score > 5/9) is overrepresented in that group presented for orthopedic problems (7).

Figure 2. Relationship between orthopedic pathology and obesity.
Lhoest 2004 (quoted by Diez and Nguyen in the Encyclopaedia of Canine Clinical Nutrition, Royal Canin 2006)

Figure 3a and 3b. Tibial plateau leveling for the treatment of cranial cruciate ligament rupture.

Primary and secondary joint disease

In dogs, OA is the most common articular disease, but it is generally observed as a disorder secondary to developmental congenital diseases, such as osteochondritis, limb deformities, and joint development alterations. Acquired causes include trauma, cruciate ligament rupture, aseptic necrosis etc.

OA is categorized as a ***primary (or idiopathic disease) entity*** when one or more factors in the etiopathogenesis are unknown. In one study (8) 20% of 150 canine post-mortem specimens examined for stifle pathology had primary OA. In these 150 dogs, mean age was 9.6 years, and the aging process was probably the cause of the primary OA. In this study, the authors also found 12 dogs with primary shoulder OA.

Secondary OA is clearly the most common joint disease both in dogs and cats. There are several predisposing causes for the secondary degenerative articular disease. In this article, we will mention only those of greater clinical relevance, and with higher prevalence within this group.

Undoubtedly, the presence of incorrect limb alignment and disorders of hip, elbow and knee represent the most important causes for secondary OA. We will briefly describe some of their epidemiological features, since more detailed information will be provided in further chapters.

Incorrect alignment, either congenital or acquired, generates an abnormal concentration of forces on the relevant articulation, resulting in OA. Within this group, we may find elbow, carpus, tarsus and coxofemoral luxations or subluxations.

Traumatic carpal luxation is relatively frequent in injuries involving falling from heights and automobile accidents ***(Figure 4)***. In puppies, carpal laxity was observed in the Doberman Pinscher, Great Dane, Labrador, Golden Retriever, German Shepherd, and Shar Pei. Also, a gradual laxity secondary to other chronic orthopedic lesions in pelvic limbs can be observed in old and obese animals, and there is a recognized predisposition in the Doberman, Collie, Samoyed, Labrador Retriever and Fila Brasileiro ***(Figure 5)***.

In the tarsus joint, a study of 44 cases of intertarsal subluxations showed that 11 were due to trauma, and most of them were related to plantar ligament degeneration. This alteration was observed in obese animals, aged >6 years, and the more predisposed breeds were Shetland, Collie and Samoyed. Tarso-metatarsal luxations are frequently associated with serious trauma. In general, they require various types of arthrodeses since instability rapidly leads to the onset of degenerative joint disease. Tarsal hyperextension is usually associated with hip dysplasia in all the predisposed breeds (9).

Figure 4. Traumatic carpal luxation after a fall from height.

Figure 5. Some old and obese dogs suffer a gradually progressive laxity of the carpal ligaments.

Coxofemoral luxation is a frequent lesion and in 59-83% of cases, it is associated with trauma, most frequently road traffic accidents. Craniodorsal luxation ***(Figure 6)*** is observed as 78% of dog cases and 73% of cat cases, while ventral luxation is observed in 1.5-3% of cases. The percentage of re-luxation following closed reduction ranges from 15% to 71% according to different studies, whereas there is a 10% re-luxation following surgical correction.

Developmental alterations

Diet plays a key role in developmental joint disease. Nutritional secondary hyperparathyroidism is rare in puppies, but may appear in animals fed principally with meat after weaning. Pathological fractures may be observed in toy breeds showing calcium deficiency. Undoubtedly, coxofemoral dysplasia and elbow dysplasia are the disorders most frequently associated with the development of chronic degenerative joint disorders. Diet has a profound influence on the onset of these pathologies, since overfeeding growing puppies causes a more rapid growth, which increases both bone length and body weight (10). The excess weight overloads the skeleton and contributes to the development of multi-factorial diseases, such as osteochondrosis, hip dysplasia (10) and elbow dysplasia ***(Figure 7)***.

Hip disorders

Hip dysplasia is characterized by joint instability, with bilateral changes in most cases. It is a disease that affects all breeds, but large and giant breeds show a higher prevalence (11). The canine breeds most frequently affected by hip dysplasia are German Shepherd, Saint Bernard, Alaskan Malamute, Bulldog, Boxer, Collie, Old English Sheepdog, Golden Retriever, Labrador Retriever and Rottweiler and breeds show different indices of heritability ***(Tables 1 and 2)***.

Certain other breeds such as Borzoi, Greyhound, Whippet and Saluki have a lower risk for the disease. The prevalence estimated by the Orthopedic Foundation for Animals (OFA) ranges from 10 to 48%, but this may under-report the real prevalence, since the radiographs assessed by the OFA are voluntarily submitted for a negative diagnosis (12).

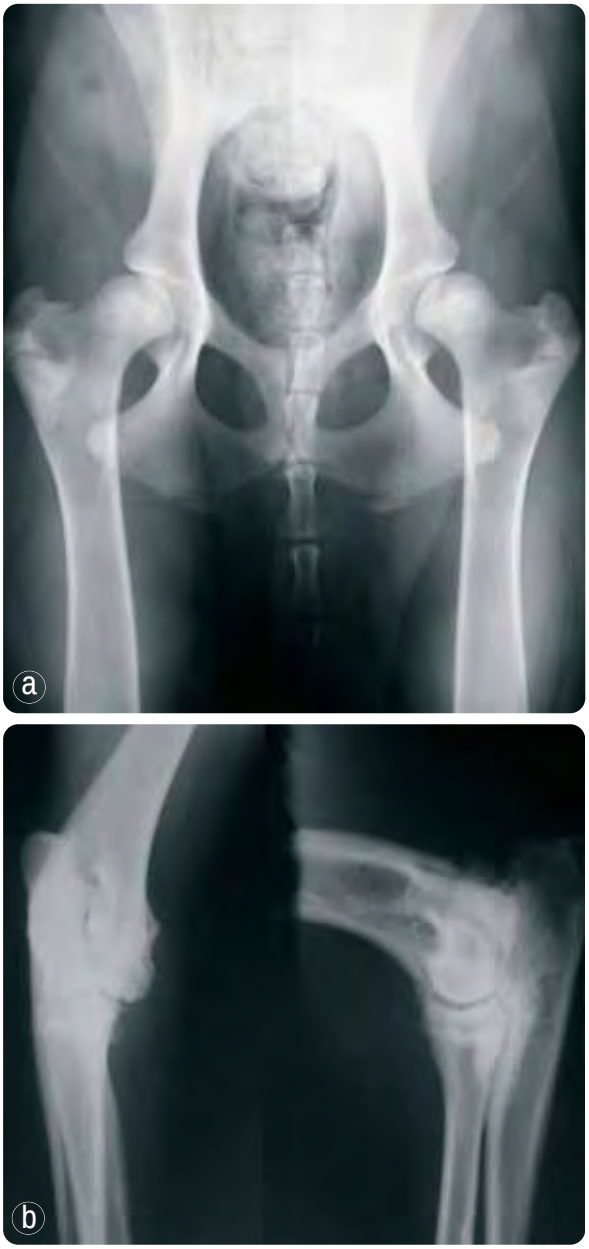
The disease affects males and females equally, and has a bimodal distribution with regard to age. A study of 15,742 dogs of several breeds (German Shepherd, Golden Retriever, Labrador Retriever, Rottweiler), showed that weight gain was a significant predisposing cause for hip arthritis, as was increasing age (13).

Elbow disorders

The humeral-radioulnar articulation constitutes one of the most complex joints in the body since it is made of irregular articular surfaces of three

Figure 6. Craniodorsal coxofemoral luxation in a dog.

Figure 7a and 7b. Hip and elbow dysplasia.



different bones. The abnormal development of the humerus distal epiphysis and of the radius and ulna proximal epiphyses during growth leads to a variety of joint changes that seriously affect congruence between joint components (International Elbow Working Group, IEWG) (14).

Diseases such as articular incongruence, fragmented coronoid process, non-union of the anconeal process and osteochronditis dissecans constitute the most common causes for early arthritis in the canine humeral-radioulnar articulation (15). A study of 55 Rottweiler puppies reported 36% of clinical signs of elbow dysplasia during the first 12 months of life, with an incidence of 7% at 3 months and 16% at 6 months, and 15% remaining stable at 1 year of age.

Large breed dogs, such as Bernese Mountain dog, Rottweiler, Labrador Retriever and Golden Retriever, German Shepherd, Bullmastiff, Collie, Saint Bernard, Chow-Chow, Keeshond, Pyrenean Mastiff, Old English Sheepdog, Airedale Terrier and Newfoundland are the most frequently affected(16).

Studies performed in German Shepherd dogs (17), Rottweiler and Bernese Mountain dogs (18) have shown that, as with other dysplasias, canine elbow dysplasia is a hereditary polygenic disorder ***(Table 3)***.

Overfeeding of diets with a high calcium content and traumatic episodes are factors that play a predominant role in endochondral ossification, and therefore have been incriminated in the pathogenesis of elbow dysplasia. Males are affected 75% more than females (19).

Stifle disorders

The stifle is particularly vulnerable to OA ***(Figure 8)*** secondary to cruciate ligament injuries, patellar luxations, and bone axis deformities. Rupture of the cranial cruciate ligament and the resulting meniscal injuries are the most frequent lesions in the canine knee.

Cranial Cruciate Ligament Rupture (CCLR)

Cranial Cruciate Ligament Rupture (CCLR) is the most common cause for lameness and pain in dogs. The relevance of this lesion was documented in a study on 369 patients that presented with hip dysplasia or hip-related lameness (20); eventually,

Table 1.
Heritability index of hip dysplasia in three breeds of dog

Hip dysplasia	Heritability	n	Author	Year
German Shepherd	0.4-0.5	2404	Hedhammar	1979
Labrador Retriever	0.34	13382	Wood	2000
Rottweiler	0.58	2764	Maki	2000

the diagnosis indicated partial or complete CCLR. Many predisposing factors have been associated with this disorder, such as age, genetics, obesity, immunity mechanisms, and tibial plateau inclination. Some of these factors are now under study. In an attempt to identify a potential partial penetration of recessive genes in the Newfoundland breed, the genetic maps of 90 Newfoundland dogs were studied. There was a significant association between CCLR (21) and chromosome 3. Other studies (*i.e.* 22) showed a higher incidence in the Rottweiler and Labrador Retriever, and a lower incidence in the Greyhound, Basset Hound and Old English Sheepdog.

Another factor that might be relevant is the composition and anatomy of the fibers of the cruciate ligament (23). These were found to be significantly thinner in the Labrador, compared to those of the Greyhound.

Epidemiological studies (*i.e.* 24) have shown that other predisposed breeds include Labrador Retriever (21%), German Shepherd (13%), and Golden Retriever (11%). The prevalence of CCLR as a cause for lameness was 32%. Limb distribution indicated 29% in left limbs, 28% in right limbs, and 43% bilateral cases. According to these data, it is crucial to rule out a CCLR in patients with pelvic limb lameness due to other suspected entities.

Patellar luxations

Patellar luxations can be grouped into the medially luxating patellas (75%) and the laterally luxating patellas (25%), either unilateral or bilateral. They mainly affect miniature and toy breeds (Chihuahua, Pomeranian, Poodle, Pekingese, Yorkshire Terrier, Pug, among others), although medium, large (Chow Chow, German Shepherd etc.) or giant breeds can also be affected. Studies have shown that it is a hereditary polygenic disease (25), and females are affected 1.5-fold more than males in small breeds. Although signs may be present from birth, they are usually observed from 3-4 months of age. In large breeds the sex incidence might be different. For example, in a study on 70 large dogs

Table 2.
Incidence of hip arthritis in 206 dogs of various breeds admitted to the Dover Veterinary Clinic. Bogotá, Colombia. 1997 - 2006

German Shepherd	43
Standard French Poodle	12
Labrador Retriever	38
Lhasa Apso	1
Standard Schnauzer	5
Basset Hound	7
Mixed breed	21
American Cocker Spaniel	13
Bulldog	4
Maltese	4
Dalmatian	2
Saint Bernard	8
Cairn Terrier	1
English Cocker Spaniel	5
Miniature French Poodle	8
Golden Retriever	3
Keeshond	1
German Pointer	1
Rottweiler	17
Wire Haired Fox Terrier	1
Short-haired Dachshund	2
Boxer	4
Old English Sheepdog	9
Pyrenean Mountain Dog	1
Miniature Pinscher	1
Beagle	1
Pekingese	1
Great Dane	2
Airedale Terrier	1
Bouvier des Flandres	1
Collie	1
Siberian Husky	7
Samoyed	2
Giant French Poodle	3
Akita	2
Pug	1
Shih Tzu	2

Table 3.
Heritability index for elbow dysplasia in two breeds of dog

Elbow dysplasia	Heritability	n	Author	Year
German Shepherd	0.28	2645	Janutta	2005
Labrador Retriever	0.53	738	Ohlerth	1998

Figure 8. Secondary OA to cruciate ligament injuries.

with patellar luxations, it was observed that 45 were males and 25 females, while 35 animals showed bilateral luxations.

Lateral luxation in toy and miniature breeds is most commonly observed in animals from 5-8 years of age. The hereditary cause remains unknown. The skeletal abnormalities are minor.

Lateral luxation in large and giant breeds is most commonly observed in the Great Dane, Saint Bernard and the Irish Wolfhound. Certain elements, such as coxofemoral dysplasia, that cause *coxa valga* (increasing the inclination angle of the femoral neck) and increase the anteversion of the femoral neck are related to lateral patellar luxation. These deformities generate an internal rotation of the femur with lateral torsion and valgus deformity of the distal femur, which are mechanisms that laterally displace the quadriceps and the patella.

References

1. Pedersen N, Morgan J, Pool R. Enfermedades articulares del perros y el gato. En Tratado de medicina interna veterinaria, Stephen J. Ettinger. Tercera edición. *Intermédica* 1992, pp. 2449-2499.
2. Poole A. An introduction to the pathology of osteoarthritis. *Front Biosci* 1994; 4: 662-670.
3. Alexander J, Early TA. Carpal laxity syndrome in young dogs. *J Vet Orthoped* 1984; 3: 22.
4. Patronek G, Waters D, Glickman L. Comparative longevity of pet dogs and humans, Implications for gerontology research. *J Gerontal A Biol Sci Med Sci* 1997; 52 B: 171-178.
5. Richardson D, Toll P. Relationship of nutrition to developmental skeletal disease in young dogs. *Vet Clin Nutr* 1997; 4: 6-13.
6. Kealy R, Olsson S, Monty K, *et al.* Effects of limited food consumption on the incidence of hip dysplasia in growing dogs. *J Am Vet Med Assoc* 1997; 210: 222-225.
7. Lhoest E. *Assessment of nutritional intakes in hospitalised carnivorous.* Mémoire présenté en vue de l'obtention du Diplôme d'Etudes Approfondies en Sciences Vétérinaires, 2004: 28 p; Faculty of Veterinary Medicine, University of Liège, Belgium.
8. Tirgari M, Vaughan LC. Clinico-pathological aspects of osteoarthritis of the shoulder in dogs. *J Small Anim Pract* 1973; 14(6): 353-360.
9. Campbell J, *et al*. Intertarsal and tarsometatarsal subluxation in the dog. *J Small Anim Pract* 1976; 17: 427.
10. Hadhammar A, Krook L. Overnutrition and skeletal disease; an experimental study in growing Great Dane dogs. *Cornell Vet* 1974 ; 64 (Suppl 5): 1-59.
11. Corley EA. Elbow dysplasia in the German Shepherd dog. Dissertation Colorado State University. Fort Collins. Co 1966.
12. Todhunter R, Lust G. Displasia de cadera: patogenia. En Tratado de cirugía en pequeños animales. Tercera edición. *Intermédica* 2006; 143: 2294-2305.
13. Smith GK, Mayhew PD, Kapatkin AS, *et al*. Evaluation of risk factors for degenerative joint disease associated with canine hip dysplasia in German Shepherd dogs, Golden Retrievers, Labrador Retrievers, and Rottweilers. *J Am Vet Med Assoc* 2001; 219: 1719-1724.
14. Olsson S. The early diagnosis of fragmented coronoid process and osteochondritis disecans of the canine elbow joint. *J Am Anim Hosp Assoc* 1983; 19: 616.
15. Read RA, Armstrong SJ, Black AP, *et al.* Relationship between physical signs of elbow dysplasia and radiographic score in growing Rottweilers. *J Am Vet Med Assoc* 1996; 209(8): 1427-1430.
16. Padgett GA. Mostosky UV, Probst CW. The inheritance of osteochondritis dissecans and fragmented coronoid process of the elbow joint in Labrador Retrievers. *J Am Anim Hosp Assoc* 1995; 31: 327-330.
17. Corley E. Hip Dysplasia: A report from the orthopedics foundations for Animals. *Semin Vet Med Surg (Small Anim)* 1987; 2: 141.
18. Swenson L, Audel L, Hedhammar A. Prevalence and inheritance of and selection for elbow arthrosis in Bernese Mountain dogs and Rottweiler in Sweden and benefit: cost analysis of a screening and control program. *J Am Vet Med Assoc* 1997; 210(2): 215-221.
19. Lewis DD, Parker RB, Hager DA. Fragmented medial coronoid process of the canine elbow. *Continuing Education* 1989; 11(3): 703-714.
20. Powers MY, Martinez SA, Lincoln JD, *et al.* Prevalence of cranial cruciate ligament rupture in a population of dogs with lameness previously attributed to hip dysplasia: 369 cases (1994-2003). *J Am Vet Med Assoc* 2005; 227(7): 1109-1111.
21. Wilkie VL, Ruhe A, Conzemius MG, *et al*. Predisposition to rupture of the cranial cruciate ligament in the dog is genetically associated with chromosome 3 (abstract). *Proceedings 2nd World Veterinary Orthopedic Congress*, Keystone, Colorado, USA 2006, pp. 35.
22. Duval JM, Budsberg SC, Flo GL, *et al.* Breed, sex and bodyweight as risk factors for rupture of the cranial cruciate ligament in young dogs. *J Am Vet Med Assoc* 1999; 215(6): 811-814.
23. Wingfield C, Amis AA, Stead AC, *et al*. Comparison of the biomechanical properties of Rottweilers and racing Greyhound cranial cruciate ligaments. *J Small Anim Pract* 2000; 41: 303-307.
24. Whitehair JG, Vasseur PB, Willits NH. Epidemiology of cranial cruciate ligament rupture in dogs. *J Am Vet Med Assoc* 1993 ; 203: 1016-1019.
25. Cairo J. Osseous pathologies during growth. *1st International Congress on the Spanish Mastiff Dog CIME* Navarrete, Spain 2005, pp. 28-30.