

# Investigation and management of canine osteoarthritis

Rob A. Pettitt, Alexander J. German

**Lameness in dogs will be a familiar part of any small animal practitioner's caseload. Osteoarthritis is a common cause for this lameness, although it is often secondary to a primary inciting cause; so treatment and management may need to address the primary inciting cause as well as the pain associated with the arthritis. Management of the condition involves a combination of medical and surgical options, and weight management can often be crucial in reducing pain and improving patient mobility. In this article, Rob Pettitt and Alex German explore the multifactorial elements in both investigating and managing this condition in dogs.**

OSTEOARTHRITIS is the most common cause of arthritis in the dog and affects up to 20 per cent of the adult canine population. Other causes of arthritis include, for example, immune-mediated disease and sepsis. In dogs both primary and secondary forms of osteoarthritis occur although the secondary form is far more common. This form occurs following injury or insult to the affected joint, for example, cranial cruciate ligament rupture, articular fracture or osteochondrosis, which initiates the biochemical cascade leading to a common pathway of arthritis.

The susceptibility of any individual to osteoarthritis is related to factors such as genetics, age and systemic factors such as obesity. Superimposed on this inherent susceptibility are local factors such as instability and injury to the joint itself. Models of osteoarthritis are well documented in the literature (for example, Dieppe and Lohmander 2005) but are not within the scope of this article.

Clinically, the major presenting signs are lameness, stiffness, exercise intolerance or an unwillingness/inability to climb or jump. The signs can be attributed to the primary inciting cause, pain associated with arthritis or a combination of both.

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## Box 1: History taking for suspected osteoarthritis

More specific questions that need to be asked when taking a history for a suspected case of osteoarthritis include:

- duration of lameness;
- clinical progression;
- response to any treatment;
- any history of trauma or other inciting causes;
- behavioural changes;
- response to amount of exercise performed; and
- effects of weather.

## Investigating osteoarthritis

### History

It is important to start with an accurate and complete history when assessing patients with osteoarthritis (Box 1). In dogs, osteoarthritis has specific breed and age predilections so the signalment of an animal may help the clinician in reaching a diagnosis. For example, hip dysplasia is present in very young medium- to large-breed dogs and the secondary radiographic changes are evident from a very early age.

The most common manifestation of osteoarthritis is so-called 'inactivity stiffness'. Owners report that their pet's lameness seems to resolve during exercise but then worsens after periods of rest following these bouts of activity. Other common presentations include a change in the animal's ability to climb, for example, the stairs, or jump, such as into the back of the car.

As part of the history taking and ongoing management of osteoarthritis there have been recent efforts to design and validate client-based questionnaires that provide a summative score and can be used to assess the severity of the disease at the outset and the response to any treatment. Although these questionnaires have not been fully validated, they provide a useful tool in the management of osteoarthritis and are available either as downloads or under licence (Brown and others 2008, Walton and others 2013).

### Physical examination

Osteoarthritis is usually secondary to a primary inciting cause so a diagnosis of osteoarthritis alone is usually insufficient and the clinician needs to identify the primary cause. A physical examination should be systematic and complete. It is useful to compare the contralateral limb when assessing the range of motion, and also when looking for soft tissue swelling and muscle atrophy. However, since the most common forms of orthopaedic disease (eg, cruciate disease, elbow dysplasia and hip dysplasia) can frequently present bilaterally, this is not always useful.

A complete analysis of the gait should be performed. This is most commonly done in two ways:

- The patient can be examined while in the consultation room during the history taking. This can often reveal very subtle lameness and allows the clinician to monitor the animal lying down and standing up, as well when walking around the consultation room.
- Further analysis of the gait should be made in an area that allows the animal to be walked and trotted in a straight line. The animal should be observed walking away from and back towards the clinician, as pelvic limb lameness is often more obvious when walking away and thoracic limb lameness more obvious when walking back towards the clinician.

This gait analysis is usually performed before the physical examination as the lameness may be worsened by the examination, although repeated single joint examination followed by immediate gait analysis may help to localise lesions, especially in the more subtle cases.

## Box 2: Clinical and physical signs associated with osteoarthritis

These signs include:

- lameness;
- reluctance to exercise;
- inactivity stiffness;
- pain;
- joint effusion;
- muscle atrophy;
- joint thickening;
- altered range of motion;
- altered gait; and
- altered behaviour.

Osteoarthritis is associated with a variety of clinical and physical signs that are similar to many joint-related conditions (Box 2).

Assessing thickening and effusions in the hip and shoulder are not possible due to the presence of the overlying muscle masses. Assessment of the range of motion should be both to assess any reduction in the normal planes of motion for a joint, for example, flexion and extension, but also to assess abnormal increases in range of motion, such as the cranial draw test for cruciate ligament disease. It is often better to perform these latter tests under sedation as they can be painful for the patient and difficult to interpret in conscious animals.

After finishing a complete history and physical examination, the clinician will often have a good idea of potential differential diagnoses and a plan can be formulated based on this.

### Further investigations

#### Haematology and biochemistry

Haematology and biochemistry are not routinely taken in cases of osteoarthritis unless the history and physical findings indicate a reason to do so. Blood tests may be useful in older animals or where long-term medical therapy is planned.

#### Radiography

Radiography is the mainstay in clinical practice for diagnosis of osteoarthritis in dogs. However, its limitations must be appreciated as it mainly provides information on the osseous changes, such as sclerosis and osteophyte formation, providing a limited amount of information

## Box 3: Radiographic signs of osteoarthritis

Radiographic signs of osteoarthritis are relatively non-specific and include:

- osteophytosis,
- enthesiophytosis,
- subchondral sclerosis,
- effusion,
- soft tissue swelling,
- intra-articular mineralisation; and
- cysts.

about the soft tissues. Radiographic signs of osteoarthritis are relatively non-specific (Box 3).

Although the presence of osteophytes can be used to diagnose osteoarthritis, there is a tendency for clinicians to focus on these osseous changes even if they do not necessarily correlate well to severity of disease or the clinical situation seen. Elbow dysplasia, for example, produces osteophytes very slowly whereas within three or four weeks of a cranial cruciate ligament rupture there will be radiographic evidence of osteoarthritis. It has also been shown that some breeds produce more osteophytes than others despite having the same degree of hip laxity (Smith and others 1995). For this reason, it is important to always evaluate the radiographs in line with the clinical situation in order to appropriately manage the cases.

Subchondral sclerosis is commonly quoted as an indicator of osteoarthritis although its sensitivity on plain radiography is limited, due to the wide variation in exposure factors that can lead to apparent differences in density, and, in one study, detection of subchondral sclerosis was unacceptably low among board-certified radiologists (Innes and others 2004). Care should be taken to not over interpret this radiographic finding because, taken in isolation, it is not a reliable indicator of osteoarthritis. However, if present in conjunction with other radiographic findings, it can be used to confirm the diagnosis.

#### Synovial fluid analysis

Synovial fluid analysis is an under used diagnostic test in clinical practice. With osteoarthritis there are early changes that occur in the synovial fluid. In osteoarthritic joints the volume of fluid may be increased, cell counts, predominantly monocytes (>88 per cent), are usually low (less than  $5 \times 10^9$  white blood cells [WBC]/l) and can often be within normal limits (< $2 \times 10^9$  WBC/l), and the colour remains clear to pale yellow. In the early stages of the disease viscosity is not reduced although, as the hyaluronic acid concentration diminishes over time, the viscosity decreases. Hydroxyapatite crystals are common features in the synovial fluid of human patients with osteoarthritis but laboratories do not routinely test for them and the significance with respect to clinical outcome and treatment in dogs is unknown. We do not request hydroxyapatite counts from submitted samples. Biomarkers have been investigated as a possible way of diagnosing osteoarthritis and although several potential markers have been identified, none are validated in the dog.

#### Advanced imaging

Advanced imaging modalities such as MRI and CT are becoming more routinely available to clinicians and, therefore, their use is increasing in the work-up of orthopaedic cases. For patients with osteoarthritis, CT can be useful in the early stages of disease, as it may help to identify the primary lesion which may not be present or obvious on radiographs. This is particularly the case for elbow dysplasia, where the primary medial coronoid disease

is often not visible on radiographs and progression of osteoarthritis may be so slow that radiographs appear normal when taken. CT is also much more useful than radiography when investigating complex joints such as the elbow, carpus and tarsus.

MRI can be useful as it gives better information about the articular soft tissue structures such as ligaments, menisci and the synovium. The main disadvantage of MRI, apart from its expense, is that canine cartilage is very thin and most of the magnets available to veterinary surgeons are not powerful enough to have a sufficient signal-to-noise ratio to allow accurate detection of cartilage lesions.

Scintigraphy is very limited in its availability due to the restrictions governing the use of radioactive material. Its relative lack of clinical usefulness also limits its use. As it can readily identify areas of increased bone turnover, it is most commonly used in cases of occult lameness where the source of the lameness is not obvious.

#### Arthroscopy

Although mainly considered to be a surgical tool, arthroscopy also has a diagnostic application and, given its ever increasing availability, now offers the best and most cost-effective method for staging osteoarthritis in dogs (see surgical management section below). Depending upon the joint involved arthroscopic surgery may involve:

- Joint debridement and micropicking of the subchondral bone (to release mesenchymal stem cells);
- Assessment of the cartilage surfaces through observation and palpation
- Removal of loose fragments/lesions to facilitate fibrocartilage formation; and
- Surgical techniques to stabilise the joint.

### Management of osteoarthritis

The management of osteoarthritis may involve a combination of medical and surgical approaches. Owners need to be counselled from the outset that osteoarthritis is likely to be a lifelong process with flare-ups that may increase in severity and frequency as the dog ages. The approach to these cases often involves a balancing act between exercise, medical management, weight management (if the dog is overweight), and surgery.

#### Exercise

Although one study demonstrated that a short period of exercise (1.2 km of trotting) increased the degree of lameness when measured on a force platform (Beraud and others 2010), very little is really known about the effects of exercise on osteoarthritis. In people it does seem that some exercise may be beneficial and certainly in canine patients exercise should be moderated but continued. Anecdotally, no exercise may be as detrimental as doing extremes of exercise. When advising owners on exercise levels for their dog it is important to advise them to try and avoid exuberant activities such as chasing balls, agility activities or other

### Box 4: Symptom-modifying drugs used to manage osteoarthritis

The symptom-modifying drugs used to manage osteoarthritis aim to relieve the pain associated with the condition, and include:

- NSAIDs;
- paracetamol/codeine (Pardale V; Dechra);
- oral opioids (eg, buprenorphine, tramadol);
- amantadine; and
- corticosteroids.

forms of high-energy exercise. When a flare-up of osteoarthritis has occurred for most patients the best course of action is to reduce the levels of exercise to short frequent lead walks which, if appropriate, are gradually increased over a period of weeks to previous levels of exercise.

### Medical management

Drugs that are used to manage osteoarthritis can be divided into two main categories:

- symptom-modifying
- structure-modifying.

### Symptom-modifying

The main drugs that can modify clinical signs are aimed at relieving the pain associated with osteoarthritis (Box 4).

It is important for clinicians' to abide by the Cascade system when prescribing medication for the management of osteoarthritis and not just go for the more 'fashionable' options. Most cases of osteoarthritis, especially in the early stages, can more than adequately be managed with a balanced approach using licensed medication in combination with other treatment modalities, in particular, weight control.

### Non-steroidal anti-inflammatory drugs (NSAIDs)

These form the backbone of the medical options for the management of osteoarthritis and an ever increasing range of licensed products is available for dogs. NSAIDs work by inhibiting the cyclooxygenase (COX) enzyme in order to reduce prostaglandin production. Two main forms of COX exist, namely COX 1 (constitutive) and COX 2 (inducible), although this classification is somewhat simplified and crossover between the functions of the classes exist. A third class, COX 3, has been identified and may be the target for paracetamol (acetaminophen). COX 3 is found in greatest abundance in the canine brain and paracetamol has a greater ability to cross the blood brain barrier better than other NSAIDs so offers an alternative pathway for pain management. Note, paracetamol is not considered to be a NSAID as it has only weak anti-inflammatory activity.

NSAIDs have been developed to be more selective for COX 2 in preference to COX 1 in order to allow analgesia to occur without creating the common side effects (in particular gastrointestinal irritation and ulceration, nausea, diarrhoea and renal papillary necrosis)

**Table 1: Licensed NSAID products currently available**

Generic drug name	Trade name	Licensed formulation	Species
Meloxicam	Meloxidyl (Ceva)	5 mg/ml solution for injection	Dogs/cats
	Meloxidyl	1.5 mg/ml oral suspension	Dogs
	Meloxidyl	0.5 mg/ml oral suspension	Cats
	Metacam (Boehringer Ingelheim)	Chewable tablets 1 or 2.5 mg	Dogs
	Metacam	5 mg/ml solution for injection	Dogs/cats
	Metacam	1.5 mg/ml suspension	Dogs
	Metacam	0.5 mg/ml oral suspension	Cats
	Metacam	2 mg/ml solution for injection	Cats
	RevitaCAM (Zoetis)	5 mg/ml oromucosal spray	Dogs
	Inflacam (Virbac)	1.5 mg/ml oral suspension	Dogs
Inflacam		1 and 2.5 mg chewable tablets	Dogs
		5 mg/ml solution for injection	Dogs/cats
	Meloxivet (Elanco)	0.5 and 1.5 mg/ml oral suspension	Dogs
Carprofen	Carprodyl (Ceva)	20, 50 or 100 mg tablets	Dogs
	Rimadyl (Zoetis)	50 mg/ml solution for injection	Dogs/cats
	Rimadyl	20, 50, 100 mg palatable tablets	Dogs
	Dolagis (Ceva)	50 mg tablet and 120 mg chewable tablet	Dogs
Phenylbutazone	Phenylbutazone (Ayrtons)	200 mg tablets	Dogs
Mavacoxib	Trocoxil (Zoetis)	6, 20, 30, 75 or 95 mg chewable tablets	Dogs
Cimicoxib	Cimalgex (Vétoquinol)	8, 30, 80 mg chewable tablets	Dogs
Chinchophen	PLT (Elanco)	200 mg (plus 1 mg prednisolone) tablet	Dogs
Robenacoxib	Onsior (Elanco)	6 mg flavoured tablets	Cats
	Onsior	5, 10, 20 and 40 mg flavoured tablets	Dogs
	Onsior	20 mg/ml solution for injection	Dogs/cats
Firocoxib	Previcox (Merial)	57 and 227 mg chewable tablets	Dogs
Ketoprofen	Ketofen (Merial)	5, 20 mg tablets	Dogs/cats
	Ketofen	1% solution	Dogs
Tolfenamic acid	Tolfedine	4% injection	Dogs/cats
	Tolfedine	6, 20, 60 mg tablets	Dogs/cats

associated with inhibiting COX 1. A drug that selectively induces COX 2 inhibition at a concentration lower than that needed to inhibit COX 1 is potentially safer, although this is an oversimplification of the actual situation. There is not a clear distinction between the pathways of constitutive and inducible prostaglandins and, in some cases, COX 2 provides a protective effect (eg, in inflamed gastrointestinal mucosa). However drugs (eg, meloxicam and carprofen) that provide analgesia without significant inhibition of COX 1 pathways (so-called COX 2 selective) have been shown to have greater safety profiles.

Osteoarthritis is a long-term disease and management should be aimed at the chronic pain associated with it and not just the acute flare-up. Many of the drugs currently available (Table 1) are licensed for use for more than 28 days, which allows the clinician to prescribe long-term therapies although it is prudent to reduce the levels to the lowest effective dose (which may be below that stated in the data

sheets), with a return to higher doses in cases of flare-ups. It should also be noted that the efficacy of NSAIDs in individual patients can be very variable and the lack of response to one particular NSAID should not be seen as a lack of response to NSAIDs per se. If a change in NSAID is to be trialled then a few days gap (washout) should be left to reduce the risks of side effects. It may be necessary during that period to use alternative analgesia protocols to manage the pain. The licensing laws require drugs in the same class to show efficacy equivalent to current licensed products as well as equal safety so the newer products are not necessarily more efficacious.

### Paracetamol/codeine

Paracetamol/codeine (Pardale V; Dechra) is licensed in dogs for use in the management of pain but only for five days and not in conjunction with NSAIDs. Its use in the management of osteoarthritis, within the license, is therefore limited. However, in the human field paracetamol

is now routinely used in conjunction with NSAIDs as an alternating protocol and we use similar protocols in our practice, albeit off licence. The licensed dose for Pardale V is one tablet per 12.5 kg twice daily which equates to 33.33 mg/kg of paracetamol. Paracetamol alone is not licensed but the recommended dose rate is 10 mg/kg twice daily. If Pardale V is used in conjunction with NSAIDs we use it at a dose rate of 10 mg/kg which equates to one tablet per 40 kg twice daily. Paracetamol/codeine may be useful in cases

where NSAID intolerance has been reported or in cases where patients are already on steroid therapy for another reason. The course can be extended for longer than five days but this is again an off licence indication. Paracetamol should never be used in cats due to potentially fatal toxicity.

#### Oral opiates/tramadol

Tramadol is anecdotally reported to be a popular therapy given by veterinary surgeons

although there is little evidence of its efficacy and the drug is not licensed for use in dogs or cats in the UK. It has recently been reclassified as a Schedule 3 controlled drug. Tramadol is metabolised into eight substrates of which only one is active in the dog, and that is only for a short (one to two hours) period. If tramadol is used, careful monitoring of the patient is needed to ensure adequate levels of analgesia are provided (Delgado and others 2014, Benitez and others 2015).

## Case example of investigating and managing osteoarthritis in a dog

### Signalment

Six-year-old neutered male labrador retriever (Fig 1).

### History and physical examination

- Severe multi-joint osteoarthritis affecting both coxofemoral joints (Fig 2) and both elbows (Fig 3).
- Bodyweight is 54.5 kg, and the body condition score (BCS) is 9/9.

Given the severity of the osteoarthritis, bilateral coxofemoral joint replacements might be required as well as a unilateral (left-sided) elbow replacement. There are concerns regarding the success of these surgical procedures, given the degree of obesity. Given the body condition score of 9/9, the dog is approximately 40 per cent overweight (German and others 2009) and, therefore, its ideal weight is estimated to be around 32.7 kg.

### Management plan

Start with medical management in conjunction with weight management, and closely monitor clinical status by assessing clinical signs at each revisit. At each stage, review the patient and consider the need for amending the plan. Aim to delay surgery for as long as possible, so as to maximise the amount of weight lost.

NSAID therapy is started initially with a period of controlled lead-only exercise. The dog should be re-examined at regular intervals during the weight loss programme.

In this case, although an initial good response to the NSAID is noted, the lameness worsened and so paracetamol/codeine (Pardale V; Dechra) is introduced, off licence, in addition to the NSAID. A physiotherapy programme could be considered at this point.

- Weight management. A partial weight loss regime is recommended, with an initial target weight of about 15 per cent below the current weight (ie, 46 kg).
- Surgery is not considered at this stage due to the potential risks and the degree

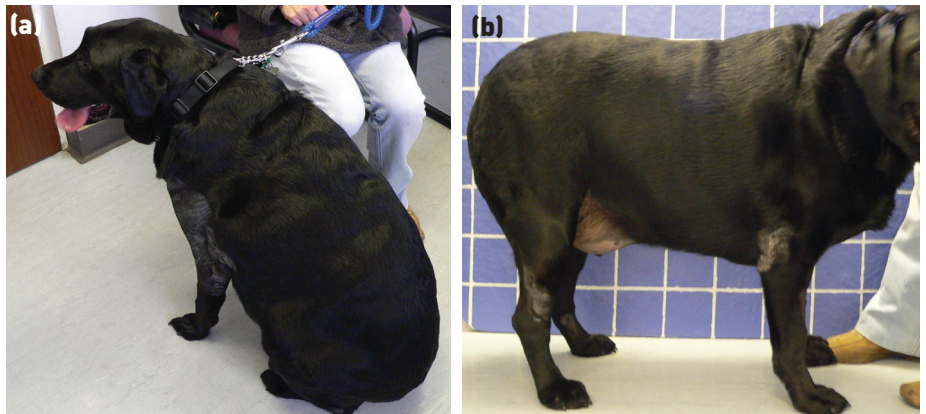


Fig 1: (a, b) Obese male neutered labrador retriever with multi-joint osteoarthritis. Bodyweight was 54.5 kg and the body condition score was 9/9



Fig 2: Ventrodorsal radiograph of the pelvis, demonstrating severe osteoarthritis in both coxofemoral joints. Photograph: J. F. Innes, T. O'Neill and S. Girling



Fig 3: Mediolateral radiograph of the left elbow joint, demonstrating severe osteoarthritis in the elbow joint. Photograph: J. F. Innes, T. O'Neill and S. Girling

of obesity. Instead the aim is to manage the pain medically and continue with the weight loss programme.

Given the dog's age, it is unlikely that returning the dog to its ideal condition will extend lifespan dramatically or prevent comorbidities (because severe osteoarthritis is already present). Instead, the main priority for weight management should be to lessen the impact of existing

diseases. A 15 per cent reduction in weight should be sufficient to improve mobility, and should be achievable within a period of two to three months. Surgery after this weight loss is more likely to be successful, with less chance of complications. Further weight management can be scheduled after surgery, with improved mobility also being expected after surgery, which will aid the weight management process further. ▶ continued on p 5

### Gabapentin and amantadine

Gabapentin and amantadine are drugs that are designed to manage chronic pain but are unlicensed. Amantadine works by acting on the N-methyl-D-aspartate (NMDA) receptor and reduces the prolonged inflammatory pain associated with chronic disease. One study of dogs showed an improvement in terms of both veterinary- and owner-assessed lameness when used with meloxicam compared to those case on meloxicam only; by day 42, the amantadine and meloxicam group had improved scores [Lascelles and others 2008].

Gabapentin works on the  $\gamma$ -aminobutyric acid (GABA) receptor and is thought to reduce neuropathic pain, although its exact mechanism is not known. The use of these drugs should not be routine and each case where this is being considered needs to be carefully judged.

In our clinic gabapentin and amantadine are generally used in those cases that are refractory to multimodal management of pain in chronic cases of osteoarthritis.

### Corticosteroids

The use of these drugs in the management of osteoarthritis is generally restricted to isolated joints where a long-acting intra-articular injection (of methylprednisolone acetate) may provide rapid alleviation of clinical signs without inducing systemic signs. The response, although rapid and significant, is often only relatively short lived and often needs repeating once or twice. Multiple repeats in excess of this are not recommended due to the detrimental effects of the steroid on the articular cartilage. Systemic steroid therapy should be avoided due to the potential side effects of the medication.

### Structure-modifying drugs

Structure-modifying drugs are less available for dogs due to the strict criteria needed to validate such drugs. The main example includes pentosan polysulfate (Cartrophen; Biopharm Australia), which is a licensed product made from beech and similar in

structure to heparin. Clinical trials of this drug have shown mixed results and two systemic reviews have concluded that only a moderate level of comfort is achieved when using this product for canine osteoarthritis [Aragon and others 2007, Sanderson and others 2009].

### Nutritional management

A lot of effort has gone into the development of nutritional means of managing osteoarthritis recently and an ever-increasing number of nutraceutical products are available to the clinician. However, the majority of these show only anecdotal evidence of efficacy with little evidence to support their claims. As opposed to pharmaceutical products, which are under the direct regulation of the Veterinary Medicines Directorate (VMD) through the Veterinary Medicines Regulations 2006, nutraceuticals are not subjected to the same restrictions unless they make specific health claims. The definition of what constitutes a

## Case example of investigating and managing osteoarthritis in a dog

### Time line of management

Time of initial presentation:

- Start weight 54.5 kg;
- Medical management;
- Weight management (high protein weight loss diet).

One month after initial presentation:

- Weight 52.3 kg;
- One month, 4 per cent total loss;
- Bilateral thoracic limb lameness with the left clinically worse. Manage with meloxicam only.

Three months after initial presentation:

- Weight 45.8 kg;
- Three months, 16 per cent total loss;
- No change in degree of lameness so continue medical and weight management.

Six months after initial presentation:

- Weight 43.0 kg;
- Six months, 21 per cent total loss;
- Due to weight loss now a suitable joint replacement candidate. Perform left elbow arthroscopy to assess cartilage (Fig 4) and to obtain biopsies on the synovium to rule out neoplasia;
- Add paracetamol/codeine (Pardale V) to protocol as lameness in left thoracic limb worsened following surgery.

Eight months after initial presentation:

- Weight 40.8 kg;
- Eight months, 25 per cent total loss;
- Review osteoarthritis and discuss possible total elbow replacement due to worsening response to medical management;
- Continue medical management with a plan for elbow replacement surgery approximately 10 to 12 months after initial presentation.

Ten months after initial presentation:

- Weight 38.0 kg;
- 10 months, 30 per cent total loss;
- Body condition score (BCS) 7/9, still estimating to have approximately 10 per cent of starting weight left to lose;
- Owner finding it challenging to comply with weight management because the rate of weight loss had slowed and the dog is showing more signs of hunger than at the start of the programme.
- Elect to stabilise weight and avoid rebound;
- Lameness persisting and to be refractive to medical management so total elbow replacement of the left elbow is scheduled.

Eleven months after initial presentation:

- Weight 38.6 kg, BCS 7/9;
- Perform left elbow replacement;
- Successful recovery;
- Dog is 4/5 lame initially but with an improving lameness over the following six months.

Eighteen months after initial presentation:

- Weight 39.0 kg, BCS 7/9;
- Left elbow mild lameness (2/5) but clicking and 4/5 lame right thoracic limb;
- Perform right elbow replacement;
- Successful recovery.

Twenty-one months after initial presentation:

- Weight 37.6 kg, BCS 7/9;
- Generalised mild gait abnormalities is well controlled with meloxicam and a targeted courses of paracetamol/codeine. Total hip replacements a possibility although there is an acceptable response to conservative management, these are not performed at the owner's request.

Thirty months after initial presentation:

- Weight 39.4 kg, BCS 7/9.

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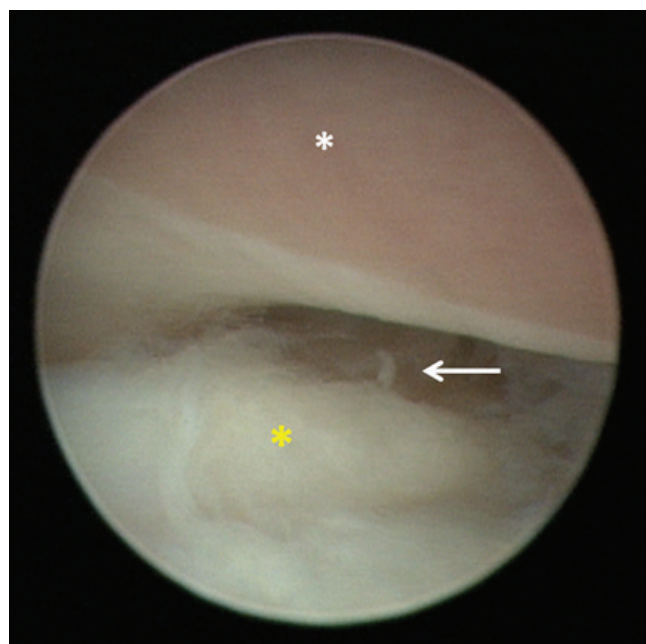


Fig 4: Left elbow joint at arthroscopy. White \* Grade four lesion of medial aspect of humeral condyle, Yellow \* Fragmented medial coronoid process, Arrow Radial head

health claim is quite vague but essentially any claim relating to a specific disease, as opposed to maintaining a healthy body system, would require the relevant marketing authority approval. If no such claims are made then regulation lies with the Food Standards Agency. The regulations are mainly limited to the composition and labelling of the product but also cover food hygiene controls during the manufacturing process.

In vitro work into glucosamine has shown that it can alter chondrocyte metabolism and this is the rationale for its use in osteoarthritis. However, the efficacy of glucosamine in vivo remains unproven and evidence is lacking as to whether oral glucosamine reaches the chondrocytes in any useful form. Similar findings have been seen with chondroitin sulphate where there has been much debate over whether the molecule reaches articular cartilage intact or as a depolymerised version. The benefits of nutraceuticals in the management of osteoarthritis are debatable and two large double-blinded negative-controlled studies reported no significant efficacy (Moreau and others 2003, Clegg and others 2006) and current evidence remains insufficient to endorse their efficacy in the management of canine osteoarthritis.

Essential fatty acids, in particular omega 3, have been shown to affect synovial fluid

metalloproteinase and tissue inhibitors of metalloproteinase concentrations following surgery for rupture of the cranial cruciate ligament (Hansen and others 2008). Further studies using objective outcome measures showed significantly increased levels of peak vertical force in dogs with osteoarthritis fed the test food diet compared to the control group (Fritsch and others 2010, Roush and others 2010). This improvement was seen in 82 per cent of the test food group compared to 38 per cent of the controls.

### Weight management

Obesity is one of the most important medical diseases in dogs, with recent studies suggesting that approximately half of all pet dogs are either overweight ( $\geq 10$  per cent above ideal weight) or obese ( $\geq 20$  per cent above ideal weight) (German 2006). Overweight dogs often have a number of health concerns and an increased risk of developing other diseases, most notably orthopaedic disease. In addition, a recent study (German and others 2012a) has also demonstrated that various aspects of quality of life are worse in obese dogs, as they tend to be less mobile and more likely to show signs of chronic pain than dogs with an ideal weight. Therefore, weight control can be a useful adjunct therapy for overweight dogs with concurrent osteoarthritis. Indeed, recent

studies (Mlacnik and others 2006, Marshall and others 2010) have demonstrated that weight loss can significantly improve the gait of obese osteoarthritic dogs, as judged by force-plate analysis. There is also evidence of improved quality of life when obese dogs lose weight, and this includes significant improvements in activity and evidence of a decrease in chronic pain. So, while the evidence for many therapeutic measures (including nutritional modification) have not been well established, the benefits of weight loss are clear. It is worth emphasising that the benefits of increased mobility can be demonstrated with only a modest amount of weight loss; improvements in gait can be observed on force-plate analysis once body weight loss exceeds 6 per cent (Marshall and others 2010). Such a degree of weight loss can be achieved within two to three months, and at least 80 per cent of dogs will be successful with such a programme (Deagle and others 2015).

### Weight management strategies

In the last 10 years, two microsomal membrane transfer protein inhibitor drugs (dirlotapide and mitratapide) have been available, which were licensed (as Stentrol; Pfizer and Yarovitan; Janssen) for controlled weight loss in overweight dogs. While the reported efficacy in published studies was good (Gossellin and others 2007, Peña and others 2014), performance in clinical practice was more disappointing, and they failed to gain widespread acceptance. In light of this, both drugs have been withdrawn from the market. Therefore, the most widely accepted strategy for weight management continues to be dietary energy restriction in conjunction with increasing physical activity.

Use of weight management should always be considered in conjunction with other forms of medical management and surgery. The sooner a weight management protocol is started, the sooner the benefits will be observed. That said, because the process can take time, it should not be used as the sole strategy, as other medical therapies can alleviate clinical signs sooner. Indeed, combining weight management with other strategies might improve outcomes; for example, if analgesia alleviates chronic pain, mobility can be improved and this might help to promote weight loss. The timing of weight management in relation to surgery should also be considered. Successful surgery can improve mobility and again may improve the outcomes of weight loss; however, delaying surgery until after a period of weight loss may reduce the risks of complications of the procedure. It might also be that, as mobility improves, the need for surgery decreases. As a general guide for an overweight dog with concurrent osteoarthritis, we would suggest a short period of weight management (two to three months) before any surgical procedure, provided that this delay is appropriate. Such a period is a reasonable compromise since, as mentioned above, the vast majority of dogs will successfully lose weight and measurable improvements in mobility will be expected.

## Case example of investigating and managing osteoarthritis in a dog

### Summary of outcome

In total, the weight loss regime lasted 294 days, and bodyweight decreased to 38.0 kg. This represented a total weight loss of 30 per cent (Fig 5). The dog remained in overweight body condition (BCS 7/9), with around 10 per cent of starting weight still to lose. The owner was finding it increasingly difficult to comply with the weight programme because the rate of weight loss had slowed and the dog was showing more signs of hunger than at the start of the programme. Therefore, bodyweight was stabilised at 38 to 39 kg, remaining within this range for the duration of follow-up (a further 18 months). Staggered elbow replacements were performed at

the end of the weight loss period, which further improved the dog's mobility. Further surgical procedures were not undertaken based on clinical signs but there was potential for total hip replacements to have been performed as well if the clinical situation justified it.



Fig 5: The same labrador retriever at the end of the weight loss phase (10 months). The weight at this stage was 38.0 kg, and the body condition score was 7/9

## Dietary management

Purpose-formulated weight loss diets should always be used because they tend to be supplemented in essential nutrients relative to energy content, which reduces the chance of malnutrition arising. These diets are often supplemented with protein and fibre, which is known to minimise signs of hunger in the pet thereby improving owner compliance. Food intake during weight loss should be accurately measured, with the exact amount fed depending upon the food used, the dog's sex and whether it is neutered. A recent study has also demonstrated that obese dogs with orthopaedic disease need a greater level of energy restriction to achieve successful weight loss than dogs that are not lame (German and others 2014). It is critical for the owner to measure food portions precisely (eg, using electronic scales), because other methods (including the use of measuring cups) are unreliable and usually lead to overfeeding. Table scraps and treats should be avoided, although some treats (especially those with a purported health benefit such as a dental chew) can be allowed, provided that the energy content is taken into account within the feeding strategy. A final consideration is how the food should be fed. Rather than using feeding bowls, puzzle feeders are a good idea, and these can either be hollow toys or modified feed bowls. The devices have been shown to slow feed intake dramatically, which can help to reduce hunger and improve enjoyment of the feeding process.

## Lifestyle management

In addition to dietary management, increasing physical activity can help with the weight loss programme. Owners often struggle with weight management programmes for their pet because of the strength of the owner-pet bond, and the fact that they are deprived of the main method they use to demonstrate love to their pet. Strategies that increase physical activity can provide an alternative means for an owner to interact with their pet. There is also emerging evidence that including such strategies into weight management programmes might improve the outcomes (Chauvet and others 2011). Suitable strategies include regular lead walking, hydrotherapy (such as the use of underwater treadmills and swimming), and various methods of increasing play activity, including the use of puzzle feeders. Not only do the latter slow food intake, but they can also increase play activity and mental stimulation.

## Monitoring the weight management regime

To maximise the chance of success, the weight management regime needs to be monitored closely, usually by performing regular weight checks. At the start, most clinicians choose to undertake such checks every two weeks, but the interval can be altered if consistent progress is made, and it better suits the owner. The same set of electronic scales should be used to ensure consistency. Bodyweight checks should be continued periodically after

the target weight has been reached (eg, at two weeks, four weeks, and three months, and then at least twice a year thereafter), in order to reduce the likelihood of rebound weight gain occurring. Continuing to feed the weight management diet, during the maintenance period, makes the likelihood of rebound less likely (German and others 2012b).

## Surgical management

Most patients with osteoarthritis can be managed with a combination of medical measures and other conservative measures. However, for some patients and some joints, the response is poor and surgical management should be considered. Although arthroscopic management is relatively routine for people with osteoarthritis, there is little evidence to support it in the management of canine osteoarthritis and so is not recommended.

The mainstay of the canine surgical management of osteoarthritis is total joint arthroplasty. Joint replacements are readily available for the hip, stifle and elbow although bespoke replacements have been performed in other joints. Of these, the total hip replacement is currently the most commonly performed and most reliable arthroplasty, with good to excellent function being achieved in more than 90 per cent of cases (Allen 2012). Such is the success of this procedure that intervention is now performed at a much earlier stage than previously recommended. Dogs in their early adult years with pain associated with osteoarthritis that is affecting quality of life may well undergo a total hip replacement as this may allow these animals to lead normal, and in some cases full working, lives. Stifle and elbow replacements are technically more challenging and remain salvage procedures where all else has failed.

In some cases, total joint replacement is not possible and arthrodesis may be a suitable alternative. This has the effect of removing the intractable pain although it produces a rigid joint and so is better suited to the low motion joints such as the carpus and tarsus. Elbow, stifle and shoulder arthrodesis is possible and tolerated reasonably well but is technically challenging. Arthrodesis of the coxofemoral joint is not possible, and so a femoral head and neck excision should be performed if replacement is not possible.

In extreme cases amputation is a possibility, although in most cases patients have multi-limb osteoarthritis so careful preoperative assessment is essential to ensure the patient will still be able to ambulate following surgery. Euthanasia is an option in some extreme cases where the welfare of the animal is a concern and treatment options have failed or are not affordable.

## Using a balanced approach

With the development of vastly improved implants and better techniques, there are many more surgical options now available to the clinician. These techniques may allow a greater response to end stage joints than was the case a few years ago but it is important

to remember that surgery in isolation may not give the complete response and, as discussed in this article, a balanced approach to the management of the disease process is essential to maximise clinical outcomes.

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