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Personal View

Face validity of a proposed tool for staging canine osteoarthritis: Canine OsteoArthritis Staging Tool (COAST)☆

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Introduction

Canine osteoarthritis (OA) is a gradually progressive degenerative disease most commonly caused by developmental abnormalities of the joints, such as hip dysplasia, elbow dysplasia, osteochondrosis dissecans and also conditions such as non-traumatic cranial cruciate ligament failure (Fox, 2011; Innes, 2012[1]). Traumatic joint injury is another important inciting factor (Fox, 2011; Innes, 2012[1]). Pain, inflammation, impaired mobility, and functional and structural changes characterise the disease and contribute to its progression (Lascelles, 2009; Loeser, 2010). Pain results in both local and distant deterioration of the musculoskeletal system as a result of decreased and altered mobility. The pathological processes of OA, such as joint capsule thickening and periosteal reactions, contribute to altered range of motion that compounds the musculoskeletal changes. Additionally, the ongoing nociceptive input into the central nervous system results in somatosensory system deterioration and central sensitization (Knazovicky et al., 2016), which contributes to the overall perception of pain. At the present time, the functional and structural changes associated with canine OA are incurable.

Early intervention has the greatest potential for providing the most effective management of OA since it provides an opportunity to initiate an appropriate long-term care plan and disrupt the progressive, vicious cycle of multidimensional deterioration. Unfortunately, greater than 50% of canine arthritis cases are diagnosed in dogs aged between 8–13 years (Mele, 2007). Even though advancing age, increasing bodyweight and obesity contribute to the progression and severity of OA (Marshall et al., 2010), this high percentage of first time diagnosis in a more elderly age bracket is concerning given the known link between OA and developmental orthopedic disease in young dogs (Innes, 2012). It highlights the probability of dogs living with undetected OA for a large proportion of their life. Identifying signs of OA-associated pain can be difficult (Sharkey, 2013), especially earlier in the disease process, and is a likely contributing factor.

Pet owners have the greatest opportunity to observe changes in their dog's behaviour because they spend the greatest amount of time with them in familiar, stress free environments where canine behaviour is expressed most normally. Unfortunately, subtle or intermittent behavioural alterations may go undetected or can be initially dismissed, especially if owners do not associate the changes with evidence of their dog being in pain (WSAVA Global Pain Council, 2014). As a result, veterinarians are frequently not consulted until the dog's behavioural changes are more marked.

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[1] See: Lascelles, B.D.X., 2016. Joint Pain in Pet Dogs and Cats. Fact Sheet No 9. International Association for the Study of Pain. Global year against pain in the joints. https://www.iasp-pain.org/GlobalYear/JointPain (Accessed 12 February 2017).

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Routine veterinary assessments can provide opportunities to detect orthopaedic changes that owners have not realised the significance of, or simply not recognised. However, practical comprehensive guidelines, incorporating both owner and veterinarian aspects for the diagnosis and staging of canine OA are lacking, and this probably contributes to the under-recognition of OA-associated pain earlier in life.

Pain and impaired activity have negative implications on canine quality of life (McMillan, 2000) and a desire to improve the situation for dogs with OA has encouraged the authors to propose an instrument, the Canine OsteoArthritis Staging Tool (COAST), to help veterinarians with the pro-active, stage-specific diagnosis and monitoring of OA in dogs. Several potential benefits are envisaged through adopting such an approach:

- Regular evaluation of preclinical dogs as well as those dogs clinically affected by OA, facilitating early detection of changes and the timely implementation or adaptation of their care plan;
- Improved understanding of the impact that OA has on the dog as a whole through the use of multiple approaches to assessment;
- A consistent approach to evaluation and use of a common terminology; and
- A multi-disciplinary team approach to care, encouraging better communication and understanding.

This article outlines the rationale and thought processes behind the construction of this proposed instrument and the 'item generation' — determination by expert opinion of what the instrument should contain and look like (face validity). It gives a detailed overview of COAST, and practical details on how it is proposed to be used.

The development of COAST

COAST was developed by a group of international specialists actively working in the fields of small animal orthopaedics, anesthesia and pain management. The group is a long-standing board of advisors purposefully recruited from nine countries to ensure geographical diversity and promote understanding of differences in local or regional approaches to veterinary medicine during discussions. In 2013, a meeting was convened to assess the current means of diagnosing and managing canine OA and to specifically identify any unmet needs or areas for improvement. The group unanimously recognised that a system defining the stages of OA, with guidance on how to effectively utilise the system for assessment and monitoring of dogs either 'at risk' or with clinical signs of the disease, was a deficiency in veterinary medicine. Since then the group has been working to address that unmet need. The authors have met in person every 2 years and refined ideas remotely during interim periods. Discussions have culminated in the development of COAST; a tool that can be applied anywhere independently of geographical area.

The selection of COAST assessment criteria

The majority of canine OA evaluations are undertaken in first opinion practice, so a key objective for the authors was to ensure that COAST would be applicable for use in primary care. Assessment procedures were therefore only incorporated in COAST if they were relatively cost effective and could be implemented by general practitioners in the majority of clinics. The authors included both pet owner and veterinarian observations to harness the strengths of each technique and balance out some well-documented weaknesses (Sharkey, 2013). The decision to incorporate these contrasting evaluations was also to encourage a 'team approach' to care and to help evaluate multiple aspects of the disease. The authors further minimised weaknesses in methodology by advising use of the most robust techniques wherever possible: For example, the subjectivity of pet owner assessments is reduced through the use of validated clinical metrology instruments (CMIs). Objective measures such as gait analysis using force plates or pressure sensitive mats were not included in COAST because they are not routinely available in most general practices. However, these tools can provide repeatable, quantitative measurements of limb use if used correctly and can be a useful source of additional information, if available, for assessment. Alternative forms of objective measurements such as accelerometers are becoming increasingly technologically advanced, easier to use and analyse and have the potential to monitor a dog's activity within its home environment. They are interesting options for the future, but further validation of these tools is required before they can be recommended as part of this diagnostic aid.

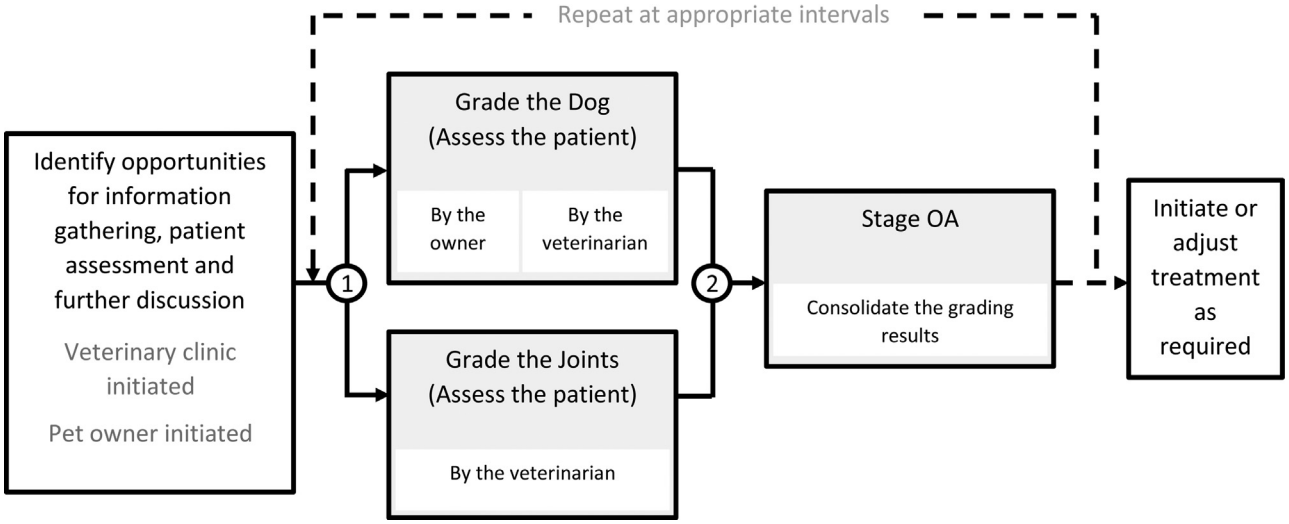

Fig. 1. Flow chart illustrating the two main steps in Canine OsteoArthritis Staging Tool (COAST; 1 = grading and 2 = staging). Regular evaluations and a two-pronged approach to grading ('grade the dog' and then 'grade the joints') in order to stage and track osteoarthritis are the fundamentals of this diagnostic aid.

How to use COAST: *A step by step guide*

Overview

COAST consists of two key steps (grading and staging) which are repeated at monitoring intervals tailored to the requirements of the individual dog (Fig. 1). A two-pronged approach to grading ensures that the impact of OA on the joints and on the dog as a whole is evaluated. The resulting grades are consolidated to provide an overall measure of disease severity. This correlates with the stage of OA. Defining the stage of OA is useful for guiding treatment and monitoring disease progression. The individual grades may also provide useful supplementary information. A detailed illustration of COAST is provided in Fig. 2.

Preparation

Time is a limiting factor in veterinary clinics and identifying opportunities for providing a professional OA assessment service within a busy schedule is an important part of preparing for COAST. There are potential benefits of multiple appointments for each dog (especially early in the evaluation process), such as increased pet owner understanding and engagement in the care plan, but this is not always practically possible for the pet owner or the veterinarian. A multi-disciplinary care team approach is encouraged to help maximise the opportunities for information gathering during one visit or provide opportunities for contact outside of clinician appointments. Maximizing the use of appropriately trained nurses, technicians or reception staff can help optimize efficiency, as can using locations such as the waiting room for questionnaire completion. Other options, such as supporting data acquisition from the home environment or providing evening or weekend disease awareness events, can offer convenience benefits for pet owners.

Another important part of preparing for COAST is defining key focus areas. In order to avoid the under-diagnosis of OA in 'at risk' populations, a suggested key focus area is the assessment of *preclinical dogs with OA risk factors*, to facilitate discussions with pet owners, establish baseline COAST scores, define the interval to re-evaluation and to ultimately improve the accuracy of disease monitoring over time. Opportunities within general practice for identifying such dogs are listed in Table 1. Particular attention should be focused on the education of owners of young, genetically predisposed breeds, or owners of dogs that have recently experienced joint injury or surgery.

The assessment of dogs with clinical signs of OA is a second important focus area. Dogs brought to the clinic because of owner perceived signs are obvious candidates for full COAST evaluation. If OA is confirmed, determining the COAST stage of OA could facilitate long-term care plan discussions and support treatment decisions. COAST is also very important for pet owner education in cases where clinical signs are intermittent or subtle and have not been recognised at home. Opportunities for the veterinary team to identify such dogs are similar to those listed for 'at risk' preclinical cases (Table 1).

It is important that pet owners understand the long term potential benefits of the COAST approach prior to initiating a full assessment, particularly in the case of preclinical 'at risk' dogs where it is possible that the outcome of the first evaluation could be 'normal' apart from the risk factor.

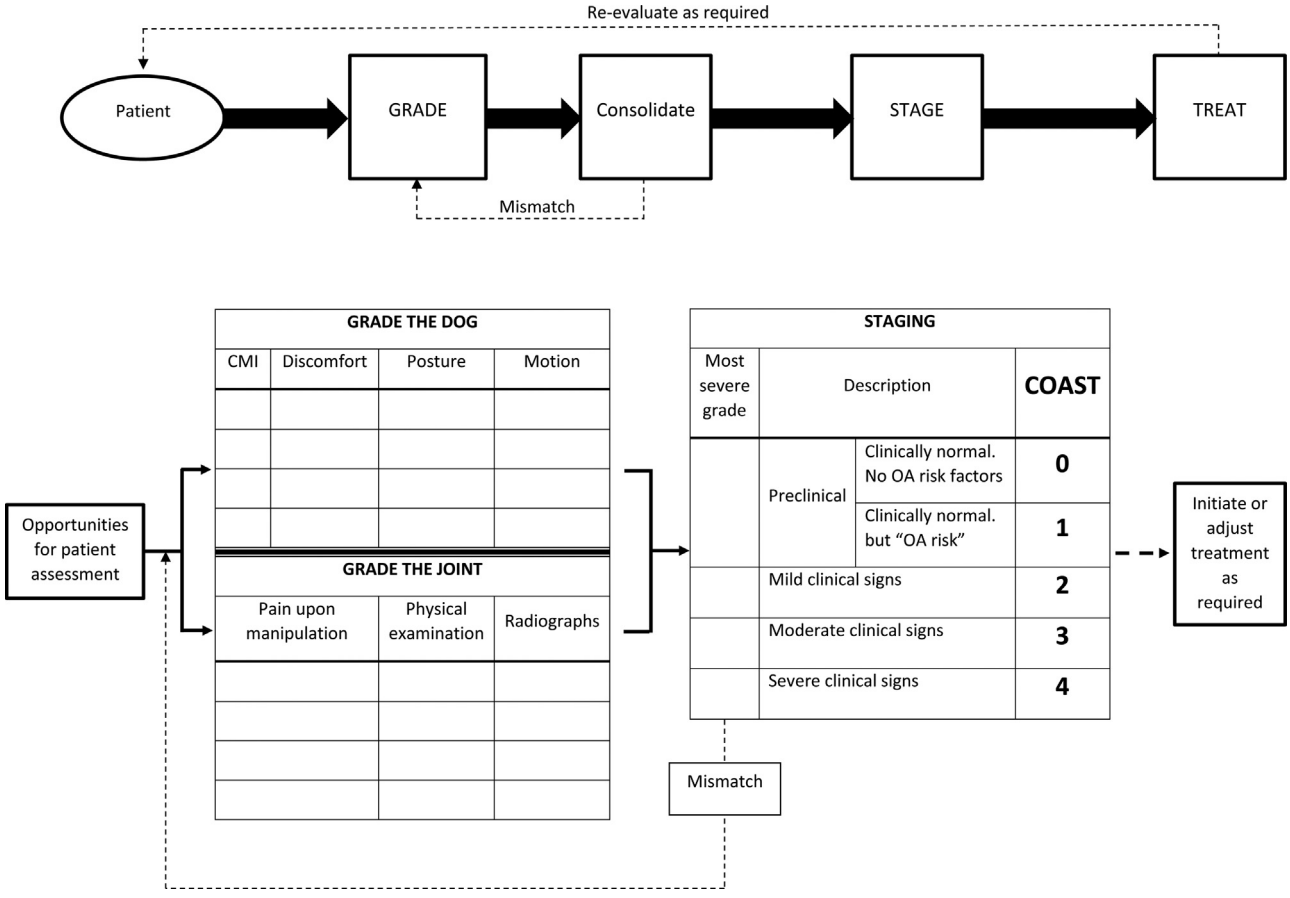

Fig. 2. An overview of the whole Canine OsteoArthritis Staging Tool (COAST) process. The criteria for evaluation, grading and staging are depicted.

Table 1
Opportunities within first opinion practice to assess dogs at risk of developing osteoarthritis.

Risk factor	Assessment opportunity
Genetic predisposition (developmental orthopedic disease)	Preventative clinic
Intense activity	General health assessment of athletes/dogs with very active lifestyle
Traumatic joint injury or joint surgery	Post injury/surgery assessment
Excess body weight	Obesity/weight management clinics
Age	Geriatric clinics
All of the above	Annual general wellness assessments

COAST grading the dog (step 1a)

'Grading the dog' involves assessments by both the pet owner and veterinarian to establish the impact of OA on the dog as a whole. Pet owner information is obtained through completion of a clinical metrology instrument (CMI) and by recording their opinion of the overall degree of their dog's discomfort over the previous month. Veterinarian requirements are focused on evaluation of posture and mobility. Details of the evaluations are provided in Table 2.

The use of a validated CMI minimises variability and subjectivity of pet owner assessments. There are a number of CMIs currently available that can help support OA assessment in dogs. They include the Liverpool OsteoArthritis in Dogs (LOAD) index (Hercock et al., 2009; Walton et al., 2013) the Canine Brief Pain Inventory (CBPI)[2] (Brown et al., 2007, 2008), Helsinki Chronic Pain Index (HCPI)[3] and the JSSAP Canine Chronic Pain Index[4] amongst others. These CMIs vary in the extent of their validation and should be selected after personal evaluation of the growing body of published data. In many cases, the CMIs can be completed by the pet owner prior to, during or following their dog's appointment at the clinic. The result can then be extrapolated to COAST (Table 2, column 1) by a health care professional. An illustration of how CMI scores can translate to COAST is provided using LOAD as an example (Fig. 3, Personal communication, J Innes). It is becoming clear that the different CMIs are measuring different things, and while the two most validated CMIs are the LOAD and the CBPI, the veterinarian is encouraged to use the one they are most comfortable with. CMIs are not considered interchangable.

Although owner assessment of the degree of their dog's discomfort is a subjective evaluation, their perception of their pet's pain is very important for case management. This evaluation is not captured by all CMIs and was therefore incorporated in COAST. In recognition of time constraints within first opinion practice, it was agreed that the owner feedback could be supervised, and if necessary the responses recorded by any suitably trained health care professional within the clinic. Repeat CMI assessment of an individual dog should be undertaken by the same person (pet owner) whenever possible, and the same CMI should be used within each dog. The authors acknowledge that communicating information about osteoarthritis, treatment

[2] See: Canine Brief Pain Inventory. http://www.vet.upenn.edu/research/clinical-trials/vcic/pennchart/cbpi-tool (Accessed 12 February 2018).
[3] See: Helsinki Chronic Pain Index by University of Helsinki. http://www.vetmed.helsinki.fi/english/animalpain/hcpi/ (Accessed 12 February 2018).
[4] See: JSSAP Canine Chronic Pain Index. http://www.dourinken.com/itami.htm (Accessed 12 February 2018).

Table 2
Canine OsteoArthritis Staging Tool (COAST) assessment parameters for 'Grade the dog'.

Pet owner observations Home/non-clinic environment		**Evaluations by a veterinarian** Veterinary clinic			
Clinical metrology instrument	**Degree of dog's discomfort**	**Effect on posture (static)**	Additional descriptors	**Effect on motion**	Additional descriptors
0 or very low score or 'not clinically affected' ☐	None ☐	Normal ☐	Static posture appropriate for breed Appropriate limb loading Appropriate body weight distribution between forelimbs and hindlimbs	Normal ☐	Symmetry Appropriate weight bearing Appropriate body weight distribution Fluent gait
Low score or 'mildly affected' ☐	Low level ☐	Mildly abnormal ☐	Subtle abnormality of limb loading Subtle shift in static body weight distribution	Mildly abnormal (subtle changes) ☐	Motion possibly affected at some gaits or with some activities Subtle stiffness in gait Subtle changes in body weight distribution Subtle asymmetry Subtle lameness No difficulty rising (getting up)
Medium score or 'moderately affected' ☐	Moderate level ☐	Moderately abnormal ☐	Obvious abnormality in limb loading Obvious shift in static body weight distribution	Moderately abnormal (obvious changes) ☐	Consistent abnormalities in motion at all gaits and activities Obvious stiffness in gait Obvious changes in body weight distribution Obvious reduction in use of affected limb Obvious decrease in stance phase Some difficulty rising (getting up)
High score or 'severely affected' ☐	Unbearable ☐	Severely abnormal ☐	Restless when standing Reluctance (difficulty) to stay standing Severe shift in static body weight distribution Severely abnormal limb loading	Severely abnormal (very obvious changes) ☐	Struggles to move/reluctant to move Severe lameness usually present Severe weight shift Marked difficulty rising (getting up)

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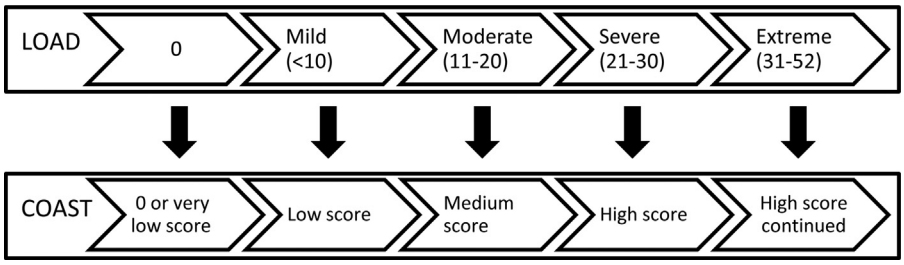

Fig. 3. Extrapolating Liverpool OsteoArthritis in Dogs (LOAD) scores to the Canine OsteoArthritis Staging Tool (COAST) clinical metrology instruments (CMI) scoring system.

options and prognosis to clients is difficult, but believe that the COAST facilitates a directed and logical approach to assessment that provides tangible outcomes (grading) that in turn will facilitate communication with the client.

For the veterinarian-evaluated parameters, the assessments are multifactorial in nature (Table 2, columns 3–6) and additional descriptors have been provided to help align the classifications between clinicians. An example of a completed 'grading of the dog' chart is shown in Fig. 4.

COAST grading the joint (step 1b)

This step specifically focuses on assessing the joint by categorising the degree of pain and how severely range of movement and function is affected. It relies entirely on veterinary evaluation and incorporates findings determined from a full orthopedic examination. Due to the multifactorial nature of each assessment, the authors have provided detailed additional descriptors to facilitate joint grading decisions (Table 3, columns 3 and 5). The 'grade the joint' chart is completed using the same approach as described for 'grading the dog'. Given that an individual dog will often have multiple joints affected to varying degrees by OA, a COAST grade should ideally be ascribed to each joint. The disease progression for each joint can then be independently and accurately monitored over time. The most severely affected joint would be used to guide treatment, unless the result from 'grade the dog' was higher (Fig. 5). Pain related to joints is probably the most difficult aspect to assess with the responses to manipulation of joints through a range of motion often being quite subtle, and the assessment of response should be based on the individual dog's baseline behavior and demonstrativeness.

COAST staging the OA (step 2)

Following a confirmed veterinary diagnosis of OA during the grading assessments, the results of the two grading pathways (steps 1a and 1b) should be compared since it is possible for the dog to have different grades from each section. For example, a dog could have moderately severe OA in a single joint, yet the effect on its body as a whole could be classed as mild if overall mobility, ability to exercise and demeanour were not affected to the same level. Conversely, a dog may have multiple joints only mildly affected by OA, but the impact of the disease on the body as a whole may be greater due to the widespread distribution of the disease.

The authors agreed upon the following principles for the COAST staging of OA as illustrated in Fig. 5:

- The most severe presenting sign is the primary guide for treatment (irrespective of how the disease manifests in an individual dog)
  - Consolidation of the two grades is required to indicate the overall severity of disease.
- The highest grade recorded for any of the parameters assessed equates to the stage of OA in that dog, as long as a 'mismatch' does not exist.

There are five possible stages of OA (0–4, inclusive) according to the COAST system (Table 4). The COAST form is provided as Appendix A: Supplementary material.

Dealing with grading mismatch

Marked disparity between the grading systems is considered unlikely, but cannot be completely dismissed. If there is a difference of *two grades or more* between the results achieved in steps 1a and 1b, re-evaluation of the dog is recommended, with particular consideration being given to the possibility of other diseases (Fig. 6). For example, only mild OA of the joints may be detected, but the dog could be severely mobility impaired due to neurological disease. If the results upon re-evaluation are consistent and no other reason for the disparity can be found, treatment should be initiated to address the most severe clinical sign. Careful monitoring of response to treatment is always recommended and is particularly important in 'mismatch' cases.

Pet Owner		Veterinarian	
CMI	Discomfort	Posture	Motion
☐	☐	☐	☐
☐	✓	☐	☐
✓	☐	✓	✓
☐	☐	☐	☐

Less severe

Most severe

Fig. 4. An example of a completed 'grade the dog' chart.

Potential benefits of implementing COAST

Staging of disease is well-established in many other fields of veterinary medicine such as cardiology (Atkins et al., 2009), nephrology,[5] dermatology (Olivry et al., 2015) and oncology (Biller et al., 2016) and has been found to be an effective foundation on which to base treatment recommendations. By standardising the approach to diagnosis and monitoring of OA using COAST, and providing a common terminology, dogs will be evaluated according to the same criteria. Consistency is an advantage in multi-clinician practices where dogs are not necessarily assessed by the same veterinarian at each visit and is equally important for long-term assessment of the same dog by the same clinician. The

[5] See: International Renal Interest Society (IRIS). http://iris-kidney.com (Accessed 12 February 2018).

Table 3
Canine OsteoArthritis Staging Tool (COAST) assessment parameters for 'Grade the joint. Ideally each joint should be graded so that disease progression can be independently and accurately monitored over time. The evaluation chart can be annotated to identify the joint being assessed.

Evaluations by a veterinarian Veterinary clinic				
Pain upon manipulation	**Passive range of movement**	Additional descriptors	**Radiography**	Additional descriptors
None ☐	Normal ☐	Normal	No radiographic signs of OA ☐	If preclinical 'at risk', the dog may have radiographic evidence of risk factors such as dysplasia and/or trauma
Mild ☐	Mildly abnormal ☐	Minimally reduced ROM No crepitus Slight joint thickening	Mildly abnormal (subtle changes) ☐	Early signs of OA Minimal osteophytes
Moderate ☐	Moderately abnormal ☐	Obvious decrease in ROM Muscle atrophy Obvious joint thickening	Moderately abnormal (obvious changes) ☐	Obvious osteophytes
Severe ☐	Severely abnormal ☐	Extremely limited ROM Crepitus Extreme muscle atrophy Severe joint thickening Loss of anatomical normality upon palpation Anatomical misalignment	Severely abnormal (very obvious changes) ☐	Advanced osteophytes Remodeling

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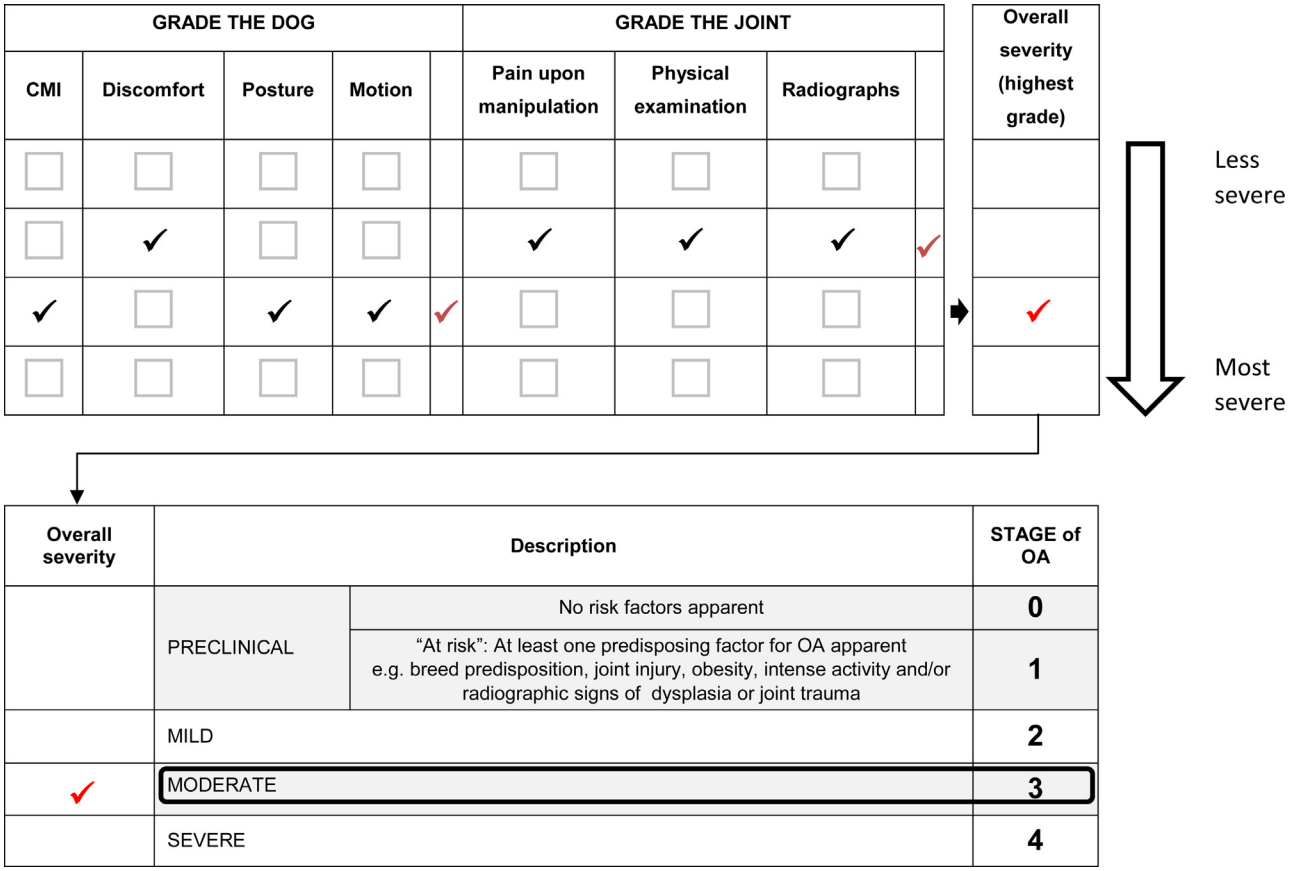

Fig. 5. Consolidation of the grades to determine the Canine OsteoArthritis Staging Tool (COAST) stage of osteoarthritis (OA). Grading consolidation is performed to establish the level at which the dog is most severely affected because this will guide treatment. The result equates to the COAST stage of OA. Classification of preclinical dogs as either stage 0 or 1 requires consideration of risk factors. In the example provided the dog was exhibiting signs of moderate severity which equates to COAST stage 3, which is the selection of the most severe grade of any assessment parameter (the main determinant of treatment).

authors propose that a consistent approach using COAST will make earlier detection of OA a possibility. It will also enable a more accurate assessment of response to therapy and introduce the possibility of more precisely tailoring treatment regime to the individual.

COAST includes two preclinical stages of OA to highlight the difference between clinically normal dogs and those that are not currently exhibiting clinical signs of OA but are at greater risk of developing OA (Stage 0 and 1 respectively). The authors believe that a clearly defined COAST Stage 1 category provides

Table 4
Staging of canine osteoarthritis (OA) with the Canine OsteoArthritis Staging Tool (COAST). The stage of OA equates to the highest grade for any of the parameters assessed. Classification of preclinical dogs as either stage 0 or 1 requires consideration of risk factors.

Description		Stage of OA
Preclinical	No risk factors apparent	0
	'At risk': At least one predisposing factor for OA apparent e.g. breed predisposition, joint injury, obesity, intense activity and/or radiographic signs of dysplasia or joint trauma	1
Mild		2
Moderate		3
Severe		4

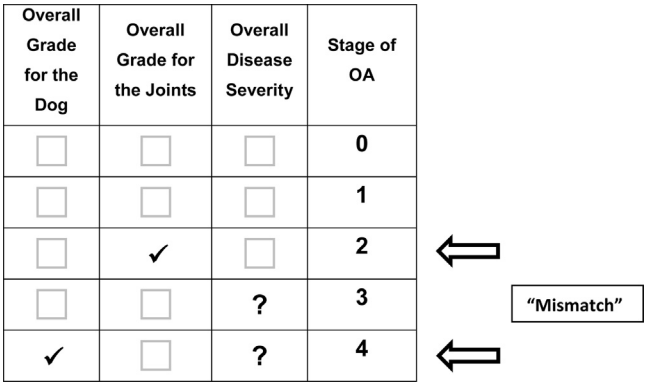

Fig. 6. Example of a 'mismatch'. Difference of two grades between the grade of the dog and the grade of the joints. Overall disease severity and stage of osteoarthritis. cannot be immediately established. Recommendation: re-evaluate the dog and consider other diseases.

opportunities for identification of at-risk individuals before clinical signs of OA are apparent by facilitating more comprehensive discussions with pet owners and helping them to understand the importance of defining what is normal for their dog as soon as possible. A regular monitoring program can then be implemented. COAST provides a standardised approach to monitoring, enabling COAST data to be compared over time. Changes will alert both the clinician and the pet owner to the possibility of OA progression and the potential need for intervention.

There are two sub-groups of dogs with clinical signs of OA which could potentially benefit from being assessed and monitored using COAST. The first group is dogs with early stages of OA that have not been recognized by the pet owner. By implementing a standardised in-clinic COAST assessment approach at key points of contact with 'at risk groups', grades or staging outcomes that are higher than expected could prompt targeted questions, help improve owner understanding and encourage further investigations if required. The second group is dogs with clinical signs of OA that are apparent to their owners. By briefly introducing the concept of COAST at the first visit and emphasising the importance of accurate documentation of owner observations in evaluating the disease as a whole, COAST can help alleviate time constraints and yet facilitate follow-up examinations. The pet owner can be asked to complete a clinical metrology instrument (CMI) and a full 'osteoarthritis assessment' appointment can be scheduled for a later date. Alternatively, if time is available for a full orthopedic examination, the pet owner can be asked to complete the CMI at the clinic, or at home following the assessment, with all of the results being consolidated thereafter. A summary of the potential benefits of COAST is provided in Table 5.

Conclusions

This report describes a novel instrument developed by an expert panel to facilitate diagnosis of OA through standardized and guided assessment. Ultimately, an effective staging tool like this may help improve pain control and general clinical management of dogs with OA by providing standardized 'scores' over time that can be related to treatment efforts. With COAST, the authors are proposing a schematic approach to diagnosing and staging canine OA, utilizing inputs from the pet owner and from the veterinarian consultation and examination. COAST is built on two foundational pillars: evaluation of the affected joint(s), and assessment of the overall impact of the disease on the health and quality of life of the

Table 5
Potential advantages of a standardised staging system for canine osteoarthritis (OA; e.g. Canine OsteoArthritis Staging Tool).

General advantages of an OA staging system	Potential additional benefits
Standardised approach to assessment	Improved transfer of information between veterinarians Harmonised approach/consistency in advice provided to pet owners Consistency in evaluation and re-evaluation of canine patients
Record keeping/log of disease severity	Guide for healthcare plan and decision making Improved evaluation of response to treatment Precise monitoring of disease progression
Enhanced monitoring of dogs at risk of developing OA	Increased pet owner awareness of canine OA Improved pet owner understanding of the disease (including benefits of regular assessment and early detection) Engaged pet owners as part of the disease management team
Encompasses early detection of OA	Provision of best standard of care from the earliest clinical signs of OA Optimised well-being of the dog at that time Potential for improved disease management (minimisation of pain, disability and behavioural problems later in life)
Optimised care	Maximised health and welfare benefits for the dog Strong partnership between the veterinary clinic and pet-owner Job satisfaction

dog. Importantly, the assessment system embraces the 'at risk' population that do not have OA or no clinical signs associated with OA. This is the first step in encouraging recognition of the fact that several factors, including developmental disease, trauma and excess body condition score, are drivers of OA and may facilitate education of owners about the need for regular assessment using COAST and discussions about preventative lifestyle changes. Verification of the feasibility, repeatability and validity of COAST is needed, and the authors expect that through this process the current tool will be adapted. In addition, an understanding what other resources are desirable to support the full use of the COAST will be determined, and drive the development of these resources. Such resources may include educational materials for veterinarians on how to perform a full observational and hands-on orthopedic examination. Information for pet owners may also be required to help them understand the risks that can drive the development of canine OA, and how to recognise the clinical signs of OA. The authors encourage use of the COAST and feedback and input that can be used to optimize the tool (please contact the COAST development group via the corresponding author [dxlascel@ncsu.edu] or the group email [COASTDevGroup@gmail.com]). It is envisaged that COAST will complement pro-active evaluations of canine health (e.g. 'wellness clinics'), provide specific monitoring opportunities for at-risk dogs (e.g. dogs attending weight management clinics and/or geriatric assessments) as well as being a useful aid in the more traditional assessment of dogs presenting with clinical signs of OA. Management approaches and treatments, based on COAST staging, are being developed as part 2 of our recommendations.

Conflict of interest statement

BDX Lascelles has received honoraria for Elanco-sponsored speaking engagements, and is a paid consultant of Elanco and for Eli Lilly. JF Innes is a member of the executive of CVS (UK) Ltd. He is the developer of the 'Liverpool Osteoarthritis in Dogs' (LOAD) CMI which is licensed to Elanco by University of Liverpool. In the last 2 years, he has received honoraria from Elanco and Norbrook Laboratories. He is also a director of Veterinary Tissue Bank Ltd. All other authors of COAST are paid consultants of Elanco and have received honoraria from Elanco within the last 2 years. None of the authors has any other financial or personal relationships that could inappropriately influence or bias the content of the paper.

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Appendix: Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.tvjl.2018.02.017.

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