Prevalence of mineralisation of the tendon of the supraspinatus muscle in dogs without clinical evidence of lameness.

Keywords: Supraspinatus, mineralisation, dog, lameness

Summary

Introduction; Mineralisation of the tendon of the supraspinatus muscle has been reported as a common finding in dogs with thoracic limb lameness. It is not clear if the mineralisation is a clinically significant cause, or a secondary effect, of lameness.

The aim of this retrospective study was to determine the prevalence of mineralisation of the tendon of the supraspinatus muscle in dogs presented to the clinic for reasons other than lameness and where lameness was not evident at the time of presentation.

Methods; Dogs undergoing computed tomography (CT) of the thorax were identified from the clinical records. The dogs selected were those presented for clinical issues other than lameness and with no history of lameness. The CT scans were screened to identify the presence or otherwise of supraspinatus mineralisation. Signalment was recorded on all the cases.

Results; Supraspinatus mineralisation was detected in 4 out of 99 dogs (4%) with all four cases found in male dogs. Medium to large breed dogs were most frequently affected, with a mean age of 9 years. Unilateral mineralisation of the left thoracic limb only was identified.

Clinical Significance. The prevalence of supraspinatus mineralisation was low in this population of non-lame dogs. This low level when compared to the higher prevalence level found in lame dogs, suggests that supraspinatus mineralisation could be associated with lameness in dogs either as an indirect result of lameness or as a primary cause.

Introduction

The canine shoulder joint is a diarthrodial, ball and socket joint formed between the humerus and the glenoid cavity. It is a relatively unstable joint, which requires stabilisation by muscles, tendons, ligaments and, to a lesser extent, the glenoid labrum (Sager and others 2009). The rotator cuff is a group of four muscles, namely supraspinatus, infraspinatus, teres minor and subscapularis, involved in maintaining the humeral head within the glenoid cavity (Drake and others 2010). The canine supraspinatus muscle originates from the whole surface of the supraspinatus fossa and inserts on to the greater tubercle of the humerus (Sager and others 2009).

In dogs, calcification of the supraspinatus tendon is a well-recognised finding, but little evidence exists as to whether this pathology is a source of pain. The prevalence of mineralisation of the supraspinatus tendon in lame dogs has been reported as 24.7% (22 out of 89) in one study (Maddox and others 2013) although it is not clear if the mineralisation was a cause of lameness or a result of the change in biomechanics due to an altered gait.

Calcifying tendinopathy of the human shoulder is a painful disorder with single or multiple deposits in or around the tendon of the muscle (De Carli and others 2014). It can affect different tendons, but it is particularly common in the supraspinatus and biceps brachii tendons (Goldman 1989) with an incidence of between 7.5 and 22% (Castillo-González and others 2014). Calcification of the tendon of the supraspinatus muscle is frequently bilateral in both canine and human shoulders (Muir and Johnson 1994, Uhthoff and Sarkar 1989).

Identification of these lesions in dogs has historically used radiographs. Currently, in humans MRI and ultrasound are the primary modalities used to image the shoulder, whereas in dogs CT and or radiographs are used. A number of reasons may account for this discrepancy and include cost, availability of scanners and also availability of ultrasonographers with sufficient skills in musculoskeletal ultrasonography. Dogs also require a general anaesthetic for MRI as compared to sedation only for a CT scan. Studies have also shown that the sensitivity and specificity of MRI is variable depending upon the sequences performed and the pathology present(Murphy and others

2008). It is also common to be simultaneously assessing the elbows of canine patients for which CT is a much better modality than radiography(Korbel and others 2001). The overall image quality and resolution of CT has significantly improved over the last ten years allowing for greater identification of lesions in the thoracic limb. The role of CT for imaging lesions of the shoulder, in particular mineralisation of the supraspinatus tendon, has been well characterised (Maddox and others 2013).

Limited research has gone into the relevance of mineralisation in the tendon of the canine supraspinatus muscle and it is therefore unknown if this mineralisation is of clinical significance. Muir and Johnson explained that in their study of the cases of shoulder calcifying tendinopathy, around fifty percent of the scapulohumeral joints were asymptomatic (Muir and Johnson 1994) and the study by Maddox and others suggested that although the supraspinatus lesion was often present, the significant pathology was more often not in the shoulder (52/94 dogs)(Maddox and others 2013).

The aim of this study was to document the prevalence of the lesion in non -lame dogs to add further to the literature of this pathology of unknown significance. The hypothesis for this current study was that mineralisation of the tendon of the supraspinatus muscle has a low prevalence in non-lame dogs.

Objective

There is no data in the veterinary literature describing the prevalence of this mineralisation in dogs that have no history of lameness. The objective of the study was to determine this prevalence in a group of dogs undergoing a CT examination for reasons other than lameness and to identify if there is a difference between non-lame and lame animals when comparing this cohort with historical data from the literature.

Method

The SharePoint Imaging Computer Tomography database at the Small Animal Teaching Hospital, University of Liverpool were searched by the lead author for dogs that had undergone a CT scan of the thorax over a twelve-month period between 2018-2019 using the search terms 'canine' and 'computed tomography'. The retrieved cases were reviewed to confirm that the complete glenohumeral joints and surrounding musculature were included in the scan -where they were not, the case was excluded from the study. Client owned dogs of any age, breed, sex and weight were considered. Any dogs with a history of lameness recorded in their clinical records, who were lame on presentation or who had tumours of the thoracic limbs were excluded. CT examinations were carried out using an 80 slice multidetector CT scanner (Aquilion Prime 80, Toshiba Medical Systems Corp, Tokyo, Japan.) with the dogs positioned in sternal recumbency with the limbs cranially positioned. Left and right limbs were scanned simultaneously. Scanning parameters were dependent on the area of interest (primarily thorax in these cases) but most images were acquired using 1mm slice collimation, 120kV and 100-150mAs. Reconstructions were generated with a 1 mm slice thickness using a standard (soft tissue) kernel and a sharp (lung) kernel. Reconstructions with both standard and sharp algorithms were available for review. Images were viewed on a computer workstation using proprietary software (Horos (Horos Project, Pixmeo SARL, Geneva, Switzerland). Each CT scan was assessed by the primary author (RA) and positive findings confirmed by a board-certified radiologist (TM) using 3D multiplanar reconstructions (MPR) with a bone window (window level 700 HU/window width 4000 HU). Shoulders of every CT scan were assessed individually. On the CT scan, the scapular spine of the right shoulder was found initially, and the right supraspinatus muscle located. Any mineralisation findings were recorded against the patient ID and which shoulder it was in. The length and width of the mineralisation was measured using an inbuilt measuring tool, and a transverse image of the mineralisation in the muscle was taken. If no mineralisation was found in one supraspinatus muscle, then it would be recorded as negative. The left shoulder was similarly evaluated. The age, breed, neuter status, sex and weight of all the dogs with mineralisation of their supraspinatus muscles was recorded.

Results

Ninety-nine cases met the inclusion criteria for this study. Breeds represented were: Labrador Retriever (15), crossbreed (12), Springer Spaniel (9), Boxer (6), Cocker Spaniel (6), Border Collie (5), CKCS (4), English Springer Spaniel (4), German Shepherd (4), and 34 dogs of another 27 breeds. 47.5% of the study population were female dogs (4.0% entire, 43.5% neutered), and 52.5% of the study population were male dogs (17.2% entire, 35.3% neutered). The mean age of the dogs was 9 years old (range 0.7 to 14). The mean weight was 21.7kg (3.1kg to 49.4kg).

A total of four cases were found to have mineralisation in the tendon. The left thoracic limb was unilaterally affected in all cases. The age range of these four cases was 7 to 10 years old, and the weight range was 28.9kg to 49.4kg. All mineralisations were in male dogs, with three neutered and one entire. Breeds affected were the Boxer (n=2) and one each in the German Shepherd and Greyhound.

The size of the supraspinatus mineralisation varied. The smallest mineralisation of 3.67mm diameter (circular in shape) was found in the youngest and also the lightest of the dogs, which was a Greyhound. The Boxer breed dogs had mineralisations of 7.16mm x 4.61mm and 1.43mm x 7.93mm. The mineralisation in the German Shepherd dog, which was the heaviest of these 4 cases, was 11.6mm x 3.28mm. Figure one shows a 3D surface rendered image of a supraspinatus mineralisation.

Mineralisation was also found in the bicep muscles in four dogs and enthesophytes were identified in two cases, but these were different dogs from those with supraspinatus mineralisation.

Discussion

Calcifying tendinopathy of the supraspinatus tendon has been possibly associated with lameness in the dog but it has also been reported as an incidental finding (Canapp and others 2016, Maddox and others 2013). Similar changes exist in the human shoulder, with 80% of the mineralisations occurring in the supraspinatus tendon, where up to 20% are noted as incidental findings in asymptomatic patients (Serafini and others 2009). Mineralisation has been suggested to be a cause of lameness in the dog, potentially as an impingement on the biceps' tendon, although there is conflicting and weak evidence to support this (Canapp and others 2016, Lafuente and others 2009, Laitinen and Flo 2000). The lesions in those studies, unlike the findings of this one, were often bilateral with a unilateral lameness. Where they were surgically removed, some improvement was noted but the authors concluded this was not necessarily due to the surgery itself (Lafuente and others 2009). In humans there are reports that show that 7% of symptomatic people have calcification of the tendon whereas 7-20% of asymptomatic patients have similar findings (Speed and Hazleman 1999) .

Our study results suggest that supraspinatus mineralisation is present in non-lame dogs, although at a significantly lower frequency, which could imply a link to thoracic limb lameness. This prevalence is lower than the Maddox study which reported a 24.7% prevalence looking at the same pathology in lame dogs albeit with a different study population (Maddox and others 2013). Care must be taken when interpreting results from different study populations but the large difference in prevalence of the lesions between the two studies, where the major selection criteria differed only in lame or non-lame, is of interest. Our study results suggest that supraspinatus mineralisation is still present in non-lame dogs, but at a significantly lower frequency and so it is possibly linked to thoracic limb lameness. Supraspinatus mineralisation was shown to be more prevalent in dogs presented with lameness albeit the localisation of the lameness was frequently not the shoulder itself (Maddox and others 2013) so the role/ effect of the lesion is not currently understood.

The primary initiating factor in causing calcium deposits is considered to be hypoxia of the tendon (Worrall and others 1990) and, in a microangiographic study, the area of the supraspinatus adjacent to the greater tubercle of the humerus was identified as a hypovascular area predisposing to hypoxia (Kujat 1990). This leads to fibrocartilaginous transformation and the depositing of calcium crystal deposits within the tendon. It is possible that any alterations to the gait of an animal could potentially lead to altered blood flow to a region that is already predisposed to hypoxia and therefore potentially increase the mineralisation of the tendon. This may help explain why the prevalence of supraspinatus mineralisation is higher in lame dogs but more as an effect of the lameness rather than a primary cause.

Mineralisation of the biceps' tendon was identified in 4 dogs (4%) which was similar to the finding of the Maddox study where 6/89 (6.7%) of cases had the same mineralisation and the Muir and Johnson paper who reported a 2.1% prevalence (Maddox and others 2013, Muir and Johnson 1994). The four dogs in our study were different from those that had mineralisation of the supraspinatus tendon. As reported in the Maddox paper, the significance there was unclear as the majority of dogs with mineralisation of any periarticular muscles of the shoulder were either not lame or had lameness localised to another region (Maddox and others 2013). In our study, a reduced number of mineralisations' were noted in the supraspinatus tendon but similar numbers of mineralisation of the biceps' tendon were recorded. The clinical significance of this is unclear, as none of our cases were reported as lame and, in the Maddox study, no association was found between mineralisation of any peri-articular structure and shoulder pain and/or lameness (Maddox and others 2013) although a low statistical power could explain this too. Based on this, the association between mineralisation of a peri-articular muscle(s) of the shoulder and its contribution to lameness cannot be completely excluded.

From the results there does not seem to be a genetic disposition but, due to the low prevalence in this study, a larger sample size would be required to confirm this. In this study 33.3% of Boxers were affected (2/6), 50% of Greyhounds (1/2) and 25% of German Shepherds (1/4). The dogs that were found to be affected were all medium to large breeds, which suggest that larger dogs are more prone to this condition. Similar findings were reported in both Maddox (2013) and Muir and Johnson (1994) studies.

Similar numbers of male and female dogs used in this study, therefore no sex bias existed, but all of the cases of supraspinatus mineralisation's were found in male dogs. The veterinary literature is inconsistent with respect to a sex predisposition. The study by Laitinen and Flo found an even split of supraspinatus mineralisation in both male and female lame dogs, whereas Maddox found lame female dogs to be more affected (Laitinen and Flo 2000, Maddox and others 2013). Both of these contradict the sex predisposition suggested by the findings in this study. This could reflect the low prevalence in this study or that there is no general sex predisposition for supraspinatus mineralisation in dogs. Of the four affected dogs, three of them were neutered and one entire.

The selection criteria had the effect of biasing towards an older population. Although the range of ages was from 7 months to 14 years, the majority of animals were over five years old giving an overall mean of nine years. Although we report that the lesion was only found in older dogs, we cannot definitively say that only older patients are affected. A lack of younger patients may have biased the data and certainly other studies have reported finding these lesions in animals as young as four months. (Canapp and others 2016, Laitinen 1994). Those dogs were identified as lame so it would be reasonable to expect to find mineralisation as per the study by Maddox and others who identified this as a common finding in lame dogs.(Maddox and others 2013)

The affected cases were generally heavier, supporting the findings of another study (Lafuente and others 2009). In that study the clinical significance of this finding was uncertain with respect to lameness and, given the findings of our study, it is hypothesised that there is no clinical relevance. Weight, along with age of the dog, did however appear to be positively associated with the size of the lesion. The size of the mineralisation does not appear to be affected by whether the dog has been neutered or not.

The left thoracic limb was the only one affected in this study but, due to the low prevalence, it is not possible to determine if this is representative of a larger population. In one other study the left thoracic limb was overrepresented potentially supporting the theory that the left limb is more susceptible to this condition but greater numbers are needed to confirm this (Laitinen and Flo 2000). Lateralisation of this lesion has been reported in humans where the condition is seen more in the dominant arm (El Rassi and others 2016). Dogs do have a degree of natural mechanical asymmetry, so called handedness, but this is much less apparent than in humans. In one study where a 10% asymmetry was set as the threshold, ten out of 19 dogs were right dominant and eight were symmetric which may account for the lesion being commonly found bilaterally (Colborne and others 2011). A meta-analysis of canine and feline lateralisation showed that 68% of dogs showed either a right or left sided paw preference with an even split between the two categories (Ocklenburg and others 2019). It is not possible from this study to determine if the lesion was isolated to the dominant side as the animals were not assessed for handedness and, as lesions were only noted on the left side, this would be in contrast to the handedness studies that confirmed asymmetry or right sided dominance.

Limitations

A major limitation of this study is the possible inclusion of some lame dogs as it was not possible for every case to have been examined by an orthopaedic specialist either before or after the CT scan. All owners were asked specifically about lameness however and cases excluded if lameness was reported. The impact of including potentially lame dogs in this study is, in our opinion, minimal given the rare occurrence of the lesion in our findings. Based on the current literature, inclusion of lame dogs would have been expected to increase the number of dogs with mineralisation rather than reduce it. A prospective study comparing lame and non-lame dogs undergoing CT scans, with a full orthopaedic history and examination by an orthopaedic surgeon would help clarify this potential discrepancy.

Whether or not patient signalment, body weight, and side of lameness influences the prevalence of mineralisation cannot be determined from this study, as it is possible that our results may underrepresent the condition in the non-lame population. There were 36 breeds represented, with only one dog in 21 of those breeds included in the study. The results are suggestive of there being no specific breed predisposition, although medium to large dogs appear to be most affected which are the category of dogs most susceptible to shoulder lameness.

The CT scans were not all performed with the same slice thickness as the cases were being assessed for different potential, non-orthopaedic related, pathologies. They were also not reconstructed with the same algorithms. It is therefore possible that lesions may have been missed albeit due to the small slice thicknesses used, these lesions would have been very small.

This was a retrospective study; therefore, we were limited in the amount of details we could collect. For example, not all of the cases had a weight for the patient, therefore we had less weights to make potential correlations with the rest of the data. Follow up on these cases was also not possible to find out if the cases with supraspinatus muscle mineralisation became lame following the CT examination.

Conclusion

The results from this study indicate that mineralisation of the tendon of the supraspinatus muscle is less prevalent in non-lame dogs when compared to the prevalence of the lesion in lame dogs in the historical data of thus proving the hypothesis. Although this may suggest that mineralisation is a potential cause of lameness, there is no strong evidence to support this and may just be a consequence of altered biomechanics or an incidental finding. Further studies are needed to evaluate the mechanical effects of lameness on this region in particular to assess changes in loading and blood supply in the lame leg. The results support the previously published data that medium to large breed, older dogs are most affected by this supraspinatus mineralisation. There was also a positive correlation between the weight and age of the dog and the size of the mineralisation.

There is a need for additional studies with a larger population size in order to assess this mineralisation prevalence in a larger number of dog breeds. A larger population size is also more likely to give more accurate results of the prevalence of supraspinatus mineralisation in non-lame dogs. This will hopefully help establish if there is a sex predisposition to supraspinatus mineralisation, as this study opposes the findings of other previous studies in this area. Prospective instead of retrospective studies will be best, as any dogs which were found to have supraspinatus mineralisation can be followed to establish if lameness occurs post identification or if it remains sub-clinical.

This study has indicated that this is a unilateral condition in non-lame dogs. These results have also identified that the left thoracic limb appears to be more affected, which agrees with some previous studies.

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Conflict of Interest

No conflicts of interest of interest have been declared

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