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Topical review

Canine Thoracic Costovertebral and Costotransverse Joints: Three Case Reports of Dysfunction and Manual Therapy Guidelines for Assessment and Treatment of These Structures

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The costovertebral and costotransverse joints receive little attention in research. However, pain associated with rib articulation dysfunction is reported to occur in human patients. The anatomic structures of the canine rib joints and thoracic spine are similar to those of humans. As such, it is proposed that extrapolation from human physical therapy practice could be used for the assessment and treatment of the canine patient with presumed rib joint pain. This article presents 3 case studies that demonstrate signs of rib dysfunction and successful treatment using primarily physical therapy manual techniques. General assessment and select treatment techniques are described.

The articular structures of the thorax comprise facet joints, the intervertebral disc, and costal joints. Little research has been conducted on these joints in human or animal medicine. However, clinical case presentations in human journals, manual therapy textbooks, and anecdotal evidence suggest that dysfunctions in these structures could account for pain in the thorax or functional impairments particularly in the upper extremities or both.[1-5] The purpose of this article is to look at what is known about the costovertebral (CV) and costotransverse (CT) joints in both humans and dogs, present 3 case reports of suspected rib joint dysfunction, and provide assessment and treatment strategies for these structures.

Anatomy of the CT Joints

Each rib has an articulation with the transverse process of the vertebra for which it shares the same number (i.e., rib 2 articulates with the transverse process of the second thoracic vertebra), which is known as the CT joint.[6] The fovea on each transverse process articulates with the tubercle of the corresponding rib. This joint is fixed by the CT ligament, which attaches just distal to the articular capsule of the tubercle, crosses the capsule, and blends with the periosteum of the transverse process of the vertebra corresponding to the rib.[6] Great variations in size and positioning of these ligaments exist in different dogs; however, they are usually largest in the last 4 ribs.[6] Jiang et al.[7] compared the spinal ligaments in the thorax among bipeds (humans), quadrupeds (multiple species, which included dogs), and pseudobipeds (avian species). They found the lateral spinal ligaments (i.e., the superior CT ligament in humans or the anterior transverse ligament and an intertransverse ligament in birds) were absent in any of the quadrupeds studied. They postulated that lateral ligaments developed as a reflection of the mechanical challenges unique to an erect spine and further presented that in reviewing the literature, they were unable to find mention of natural development of idiopathic scoliosis in quadrupeds; however, there are reports of avian models and adolescent models in man.

Takeuchi et al.[2] commented, “The anatomic structures of the canine CV joints and thoracic spine are similar to those of humans, and the range of motion (ROM) or rotations of the thoracic spinal motion segments along 3 axes do not differ markedly from those of humans.” Thus, human thorax research may help to expand our perceptions and knowledge of the canine thorax as well. Young et al.[3] studied the pain patterns of the CT joints in normal (human) volunteers. Fluoroscopic-guided injections were made into the CT joints. Subjects reported the pain to be deep, a dull ache, or a pressure sensation, with pain patterns located superficial to the injected point, ranking an average pain of 3.3 of 10 on a visual analog scale. They noted that the T2 CT injections referred pain 2 segments cranially or caudally, but no chest wall or upper extremity or pseudovisceral pains were reported. In humans, innervation of the CT joints is from the lateral branch of the thoracic dorsal rami, whereas the medial branches of the thoracic dorsal rami innervate the thoracic facet joints.[3]

Anatomy of the CV Joints

Additional rib articulations (costal fovea) are located at the cranial and caudal sides of each thoracic vertebra T1-T11 (called the cranial and caudal costal fovea or the demifacets). The rib head 1 articulates with T1 body and sometimes C7. It also articulates with the fibrocartilage between C7 and T1. The body of T12 often lacks a caudal demifacet, and T12 and T13 typically have only 1 complete fovea on each side.[6] The CV joints and rib cage play an important role in providing stability to the thoracic spine.[1] The

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Fig. 1. View of the demifacets of the costovertebral joints in the thoracic spine.

articulation of the rib head, including the support of the radiate ligament, articular capsule, CT ligament, and intra-articular ligament, plays an important role in resisting rotations around the axes in lateral bending.[2] Hence the thoracic spine may be significantly less stable when the CV joints are injured (Figs 1 and 2).

Potential Symptoms

CV joints have been shown to receive sympathetic innervations from the neighboring sympathetic segment and the segment cranial to it.[3] Human case reports have found rib dysfunctions to produce neck pain or head pain or both, shoulder pain (similar to shoulder impingement syndrome signs and symptoms), the sensation of having a useless or heavy limb, the inability to grip efficiently, pain under the scapula that refers to the chest and worsens with coughing, sneezing or deep breathing, and atypical chest pain (occasionally with tachycardia and dyspnea).[8-11] No studies could be found pertaining to clinical presentation of rib dysfunctions in dogs.

Fig. 2. The costovertebral and costotransverse joints.

Canine Case Studies of Rib Dysfunctions

Case 1

A 10-year-old neutered male Labrador Retriever presented to a physical therapist at a canine rehabilitation facility with a veterinary referral that described the problem as “a chronic issue revolving around repeated stretching when at dog parks or when exercising, sometimes accompanied with a yelp. Pain is found repeatedly at the thoracolumbar area on physical examination, and the dog is reluctant to extend the shoulders and elbows, but no further diagnostics have been administered.” The owners reported similarly, stating that the dog has stretched excessively since a puppy, and will even stop playing for stretching (downward-dog position). Over the past year, the owners had noted that the dog was frequently licking his left front paw. It had recently been prescribed a different nonsteroidal anti-inflammatory drug after the first one was not well tolerated. No relevant past medical history that could account for the stretching or paw licking was known or recounted.

On examination, the dog was not lame but did stretch several times during the appointment. The most painful areas on palpation were ribs 1-3 on the left and rib 2 on the right. The ribs throughout the left side of the caudal thorax (T7-13) were also painful on direct palpation. Treatment administered comprised mobilizations to the ribs in the form of rotational glides and distraction techniques (3 repetitions of each, then retesting for pain on palpation, and a repeat of the mobilizations to any ribs that were still painful until there was no longer pain with direct palpation). (Refer to treatment section for technique details.) Dorsal glides to the thoracic spinal facet joints (via the rib cage) were also used, and laser therapy was administered to the CV and CT joints as well. The owners were advised to perform “chest lifts” as a home exercise.

The follow-up appointment occurred 3 weeks later, at which time, the owners reported that the dog was much better and much reduced in his stretching. They had only witnessed him stretch once since his last appointment, and he was no longer licking his left front paw. On examination, there was only minimal pain on palpation of T3 spinous process and ribs 3 bilaterally. Mobilizations (as described previously) and laser therapy were provided at that time, and the dog was discharged from active treatment. Owners were contacted 1 month following discharge, and they reported to see no signs of recurrence of the stretching or licking habits.

Case 2

A 6-year-old neutered male Labrador Retriever presented to a physical therapist in a canine rehabilitation facility with a veterinary referral stating the history of a front leg lameness ongoing for 1.5 months, which worsens with exercise or after prolonged rest. No findings could be made on the veterinary examination. The dog had no relevant past medical history, and pharmaceuticals had not been prescribed.

On examination, the dog demonstrated a very subtle off-loading of the right forelimb in stance and very mild right forelimb lameness at a walk and trot. The most painful areas on palpation were the ribs 1-4 on the right, whereas ribs 1-4 on the left exhibited mild pain on palpation. The dog also had an increased abduction angle of the left glenohumeral joint compared with the right (40° left vs. 20° right); however, there was a solid stop to the abduction movement, no apprehension with the movement, and no pain with any additional glenohumeral joint testing. Presence of left glenohumeral abduction hypermobility could not be made to correlate with right forelimb lameness. The limbs were otherwise unremarkable on evaluation. Treatment comprised mobilizations (rotational glides) administered via 3 repetitions on each rib, retesting, and repeating of mobilizations to ribs that continued to demonstrate pain on palpation. Laser therapy was also provided to the ribs.

A follow-up evaluation was conducted 6 weeks later. The owner reported that the dog was doing well, and that there was no limping after the last treatment, but that there was a relapse of lameness approximately 2 weeks later, which lasted for a week and then resolved. On examination, the right rib 1 and ribs 3 and 4 were mildly painful on palpation. No lameness was detectable on gait analysis and no other areas of pain were found on physical examination. Treatments comprised laser therapy to the ribs and mobilizations (rotational glides for ribs 3 and 4 bilaterally and a cranial glide to rib 1 on the right). The dog was discharged from active treatment, and the owners were instructed to call if they saw a return of the lameness. Owners were contacted by e-mail 1 month after discharge and reported full return to all activities without lameness.

Case 3

A 7-year-old neutered Labrador Retriever presented to a canine rehabilitation facility with a veterinary referral describing a past medical history of bilateral femoral head excision owing to severe hip dysplasia at the age of 10 months and a current issue of left front lameness of 2 months, thought to be attributable to the elbow. The referral requested a full assessment and offered to provide a radiograph of the elbow if deemed necessary. The dog was assessed by another physical therapist and treated at 2 appointments consisting of general spinal mobilizations, soft tissue techniques (massage, stretching, and trigger point release), elbow mobilizations, and acupuncture, and 3 sessions of underwater treadmill therapy. No improvements were made in the lameness.

The dog was then reassessed 1 month later by a different physical therapist (this author) who found the dog to have severe pain on palpation of rib 1 on the left, mild tenderness over the left proximal biceps tendon, and mild tenderness to palpate C7 on the left. There was also discomfort to palpation over the thoracolumbar region, but no findings of pain or dysfunction in the elbows or carpi. Therapy administered on that day consisted of mobilizations to left rib 1 (caudal glide technique), massage to the scalene muscles on the left, mobilization of C7 (side-glide technique to the left), and laser therapy to each area.

On follow-up appointment 1 week later, the owner remarked that the dog was running, going downstairs, and acting like a puppy again. The dog had also had radiographs of the entire left front leg, which found no significant signs of osteoarthritis or other pathology. Examination revealed an absence of neck pain, mild discomfort with left rib 1 palpation, and mild biceps tendon tenderness on palpation. The thoracolumbar region was unchanged from the previous assessment. Treatment consisted of caudal glides to left rib 1, massage and stretching of the left scalene muscles, and laser therapy to the left rib, scalene, biceps as well as the thoracolumbar region. Mobilizations were also administered to the thoracolumbar region as well. The dog was discharged from active therapy but put on a maintenance program for a rehab checkup and tune-up every few months. The left forelimb lameness had not recurred at 3-months following his discharge from active therapy.

Assessment for a Rib Dysfunction

Assessment and treatment of rib dysfunctions is routine in human physical therapy practice, and textbooks exist to describe such techniques.[12,13] Detecting or ameliorating a rib dysfunction in the canine patient can be approached with an understanding of the local anatomy and replicating or modifying techniques from human practice.

Evaluation of tone and texture of the thoracic epaxial musculature to detect hypotonicity or hypertonicity may signal the need to assess for CV or CT dysfunction (in addition to the thoracic spine itself). The angle of the rib, the portion of the rib that is just lateral to the epaxial muscles, is the best vantage point to palpate the ribs, to feel for tone of the intercostal muscles, and to subsequently assess CV and CT joint mobility. Ribs 1-3 can be palpated medial to the scapula and accessed via the caudal aspect of the axilla. This is best done with the animal in lateral recumbency (Fig 3). Manual ventral pressure on the rib “angle” (the location described previously) can be used to determine discomfort, pain, and mobility at the CV and CT articulations (Fig 4). A muscle twitch or spasm is a common response with a CV or CT dysfunction. One cannot differentiate which of the 2 joints (CV or CT) is problematic with any kind of specificity on manual testing; however, the need to do so could be purely academic, as

Fig. 3. Assessing for rib tenderness of ribs 1-3 located medial to the scapula.

Fig. 4. Ventral pressures on the rib angles to assess for discomfort, pain, and mobility of the rib joints.

clinically it seems to matter very little. An exaggerated response to ventral rib pressures bilaterally (e.g., the animal cries, drops, or collapses) with testing could indicate a discogenic lesion. Further discussion of thoracic disc lesions is beyond the scope of this article.

Selected Manual Treatment Techniques for a Rib Dysfunction

Veterinary practitioners should be aware of 3 basic manual treatment techniques for rib dysfunction. The following techniques are classified as mobilizations. Mobilization has been described as the gentle coaxing of a movement by passive rhythmical oscillations performed at the beginning, within or at the limit of range.[13] According to Maitland et al. (2005),[13] mobilizations can be used in 2 basic sets of circumstance: (1) treatment of stiffness and (2) treatment of pain rather than stiffness.

The mechanical effects of mobilization work to restore voluntary movement, aid in cartilage nutrition, aid in intervertebral disc nutrition, aid in metabolism of soft tissue structures, and improve the rate and quality of tendon repair.[14,15] To achieve a mechanical effect, repetitive passive joint movements (oscillations) need to be carried out at the limit of the joint's available range, and tissues need to be stretched.[14]

The neurophysiological effects of mobilizations are readily validated in literature and are reportedly the prime mechanism behind reduction in acute pain and inhibition of reflex muscle

Fig. 5. Rib distraction mobilizations.

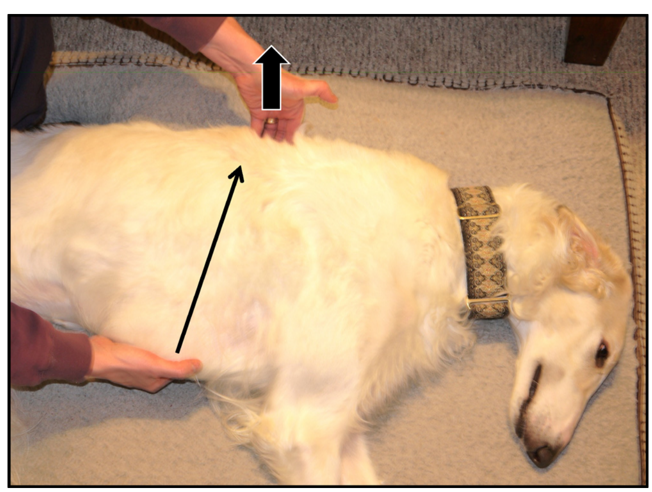

Fig. 6. Rib rotational glide.

Fig. 7. Chest lifts.

contractions.[14-19] The achievement of neurophysiological effects requires movement at the joint, which results in a hysteresis effect. The hysteresis effect involves inhibition of low threshold mechanoreceptors (groups I and II), inhibition of high threshold nociceptors (groups III and IV), both of which result in a reduction of intra-articular pressure and peripheral afferent discharge.[14,16,20,21]

Rib distraction mobilizations can be a good first attempt to treat a rib dysfunction. This technique is best done when the dog in sitting or lying. Localize the angle of the affected rib and position 1 thumb on that spot. The practitioner's other thumb should be placed across the ipsilateral side of the spinous processes of the 2 vertebras corresponding to the rib (as per the CV demifacet articulations) to stabilize the spine. The mobilization occurs by creating a lateroventral pressure with the thumb on the rib angle (Fig 5).

A rib rotational glide is an effective technique and sometimes preferable to the rib distraction technique if direct pressure over the rib is too painful. This technique can be administered with the dog in standing, sitting, or lateral recumbency. Place 1 thumb over the contralateral sides of the spinous processes of the 2 vertebras corresponding to the affected rib. The mobilization occurs by rotating the rib cage via grasping the manubrium and chest and pulling upwards in a rotary motion toward the side of the affected rib (Fig 6).

Chest lifts may be a useful generic treatment technique for a rib articular dysfunction or thoracic facet joint dysfunction. With the dog in standing position, reach underneath its chest with both hands, lace fingers together, and slowly and gently lift the torso. Repeat this maneuver a few times, slowly and rhythmically, lifting from different portions of the chest or sternum to create a movement at different segments of the thoracic spine. The animal's feet should remain on the ground at all times, and the techniques should be pain free (Fig 7).

Conclusion

This article has provided a summary of the current knowledge of canine CV and CT joint anatomy and presented 3 atypical cases of lameness or movement pattern dysfunction that on evaluation could best be localized to rib joints. Knowledge of the anatomy, manual assessment, and treatment of rib joints is lacking in veterinary research. Further investigation into these potentially painful regions is warranted to improve the pathophysiologic knowledge of causative mechanisms for dysfunction, and more importantly, to increase veterinary awareness of their existence.

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