Magnetic resonance arthrography (MRA) and CT arthrography (CTA) of the normal canine shoulder.

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Introduction and aims of the study:

In men, magnetic resonance arthrography (MRA) and CT arthrography (CTA) are well established imaging techniques and have been investigated in every major peripheral joint of the body, and have been proven to be effective in determining the integrity of intra-articular ligamentous and fibro-cartilaginous structures and in the detection or assessment of osteochondral lesions and loose bodies in selected cases. There are no clear guidelines for diagnostic imaging of articular cartilage but it is stated that CTA is better for the assessment of thin cartilage.
In dogs, the number of reports of these techniques are limited and restricted to the stifle and shoulder joint. The need for visualising the smaller intra-articular structures and joint cartilage has been emphasised in the stifle as well as in the shoulder. MRA in the canine shoulder joint has been described in detail but is limited to the use of high-field equipment.
The aim of this study was to compare low-field MRA and CTA in the visualisation of intra-articular ligaments and joint cartilage in the normal canine shoulder.

Material and methods:

Dogs.
Three clinically normal adult Beagles were used in this study to perform CTA and MRA. Furthermore, four shoulders of two Beagle cadavers were collected for gross-anatomy.

CTA.
An arthrographic CT study (CT-scanner, LightSpeed, GE Medical systems, Milwaukee, WI) was performed of each shoulder joint after intra-articular administration of 6 ml of contrast medium (diluted till 100 mg I/ ml with saline) (Visipaque 320, GE Healthcare Ireland Cork, Ireland). Transverse slices and reconstructed sagittal and dorsal images were obtained.

MRA.
Two weeks after the CTA examinations, an MRA study of each joint was performed using an open, low field MR system (MR unit, 0.2 Tesla open MR system, Hitachi Medical Corporation). T1- and T2-weighted images were made in transverse, sagittal and dorsal planes. Arthrography was performed by intra-articular injection of 0.4 ml of contrast medium (Gadobenate dimeglumine, Multihance, Bracco, Milan, Italy) and 0.2 cc epinephrine diluted 1:1000 with sterile NaCl. Eight cc of this mixture was injected in each joint and T1-weighted sequences were repeated in 3 different planes.

Anatomic specimen.
The cadaver shoulder joints were injected with 6 ml red methylmetacrylate and frozen at -18 C. Two days later the frozen specimens were sectioned into approximately 2 mm thick slab sections using an electric band saw. Two joints were sliced in transverse sections perpendicular to the glenohumeral ligaments. The 2 other joints were sliced in dorsal or sagittal sections parallel to the glenohumeral ligaments. All anatomic sections were photographed and representative anatomic images were selected. Identifiable anatomic structures were labelled with the aid of texts on canine anatomy and in accordance with accepted anatomic terminology. Afterwards, the identified structures were evaluated in all CTA and MRA images and compilations with the representative anatomic sections were made.

Results

Five transverse, five dorsal and three sagittal combinations of anatomic sections, CTA , T2-weighted MR and T1-weighted MRA images of the shoulder joint were selected. The levels at which images were obtained were indicated on transverse, dorsal and sagittal survey CT images.

On the sagittal anatomic sections, a clear view of the supraspinatus en biceps tendons in long oblique and longitudinal perspectives was provided. The red methylmetacrylate highlighted the joint space, the caudal joint pouch and the synovial lining encompassing the biceps tendon. A fine line of articular cartilage and also the lateral glenohumeral ligaments could be seen. On the sagittal CTA and MRA images all compartments of the joint space were clearly enhanced by the contrast medium. It was difficult to identify the joint space on the T2-weighted MR images as only a small amount of synovial fluid was present. The tendons of the supraspinatus and biceps muscles were very distinct on the MRA images. On the CTA and T2-weighted MR images only the tendon of the biceps muscle could be distinguished. The joint cartilage could be seen on the CTA images as a radiodense line between bone tissue and contrast medium. No glenohumeral ligaments were noticed on the CTA, MRA and T2-weighted MR images.

On the dorsal anatomic sections, identification of the biceps, infraspinatus , supraspinatus, and subscapularis tendons, as well as the medial and lateral glenohumeral ligaments was possible. The joint space was well filled with red methylmethacrylate and the fine cartilage of the shoulder joint could be seen. CT and MR arthrography enhanced the silhouette of the medial and lateral glenohumeral ligaments and the tendon of the biceps muscle. On the MRA images the tendons of the infraspinatus, supraspinatus en subscapularis muscle were clearly visible. The fine, radiodense line of the joint cartilage could only be distinguished on the CTA images. The T2-weighted MR images provide less information about the joint space compared to the arthrographic images. Only the tendons of the biceps en subsacapularis muscles could be identified on these sequence.

On the transverse anatomic sections the tendons of the biceps, infraspinatus, supraspinatus and subscapularis muscle were clearly visible. Also the lateral and especially the medial glenohumeral ligaments could be identified. The joint space with its caudal pouch and the biceps tendon sheat were well filled with red methylmetacrylate, so the shoulder cartilage could be inspected. On the CT and MR arthrograms the joint space could easily be distinguished. On the CTA and MRA images the silhouette of the medial glenohumeral ligaments and the biceps tendon could also been seen. Moreover a small section of the lateral glenohumeral ligaments was detected on the CTA images. The tendons of the infraspinatus, supraspinatus and subscapluaris muscle could only be evaluated on the MRA images, and the dense articular cartilage on the CTA images. On the T2-weighted MR images a small joint space was noted and only the tendons of the biceps, infraspinatus and subscapularis muscles could be located.

Visibility of the different structures using CTA, MRA and MR T2:

	ANATOMIE			CTA			MRA			MR T2		
	sag	dors	trans	sag	dors	trans	sag	dors	trans	sag	dors	trans
Joint space	++	++	++	++	++	++	++	++	++	+	+	+
Caudal pouch	++	++	++	++	++	++	++	++	++	+	+	+
Biceps sheat	++	++	++	++	++	++	++	++	++	+	(+)	–
Joint cartilage	++	++	++	++	++	++	–	–	–	–	–	–
Biceps tendon/silhoutte	++	++	++	++	++	++	+	++	++	+	(+)	+
Supraspinatus tendon	++	++	++	–	–	–	++	+	++	–	–	–
Infraspinatus tendon	–	++	++	–	–	–	–	+	+	–	–	(+)
Subscapularis tendon	–	++	++	–	–	–	–	++	++	–	+	++
Medial glenohumeral ligaments	–	++	++	–	++	++	–	+	+	–	–	–
Lateral glenohumeral ligaments	++	++	+	–	+	+	–	+	–	–	–	–