Effect of pelvic positioning and torsional deformity on canine acetabular morphology with computed tomography: a phantom study

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INTRODUCTION

Acetabular retroversion is widely described in humans as a cause of hip osteoarthritis and recently reported in dogs. Acetabular retroversion in dogs should be called "dorsoversion" for anatomic differences in the posture. In a recent study extrarotation of the hemipelvis on its long axis and the presence of the cross over sign (COS) were common features in a series of English Bulldogs with hip abnormalities.
Pelvic inclination has been proved in humans and dogs to have a direct influence on the acetabular version appearance. If a pelvis is excessively reclinated (ischia far from the cassette, ilia near the cassette), the acetabular cup version seems more anteverted than it actually is. In an excessively inclinated pelvis (ilia far from the cassette, ischia near the cassette), the acetabular cup version seems more retroverted than it actually is. There is no standard protocol describing CT patient positioning, slice thickness and slice selection for acetabular angles computations. The effects of patient positioning and slice selection on acetabular angles have been assessed by a relatively recent report. The purpose of this study was to evaluate with CT how the inclination and extrarotation of the hemipelvis affect acetabular angle (AA) and dorsal acetabular rim angle (DARA) assessment.

MATERIALS AND METHODS

A 16-slice multidetector CT scanner (LightSpeed 16, GE Healthcare®) was used, with a slice thickness of 0.6 mm. A normal canine hemipelvis was put in a specially designed holding device in dorsal recumbency. It was scanned with different degrees of extrarotation on its long axis (0°, 5°, 10°, 15°). Each degree of extrarotation was acquired at 0°, +20°, -20° of gantry tilt in order to mimic respectively a horizontal, inclinated and reclinated pelvis. Individual acetabular angles (IAA) were calculated in the cranial acetabulum (3rd slice from the beginning of the acetabulum) and central acetabulum (12th slice from the beginning of the acetabulum). Dorsal acetabular rim angles (DARA) were calculated in the central acetabulum (12th slice from the beginning of the acetabulum). Both IAA and DARA were calculated for each degree of extrarotation and gantry tilt. Pearson's correlation coefficients were calculated between acetabular angles, inclination and extrarotation of the hemipelvis. Correlation was judged very strong if the correlation coefficient was at least 0.8, moderately strong if the correlation coefficient was 0.6 up to 0.8, fair if the correlation coefficient was 0.3 up to 0.5 and poor if the correlation coefficient was less than 0.3.
Dorsoversion of the acetabulum was present on CT images if the ventral acetabular rim was laterally to the dorsal rim.

RESULTS

A strong negative correlation was found between cranial and central IAA and pelvic inclination for each degree of extrarotation. A strong negative correlation was found between cranial and central IAA and pelvic extrarotation for each degree of inclination. There was a strong positive correlation between DARA and pelvic inclination for each degree of extrarotation and a strong positive correlation between DARA and pelvic extrarotation for each degree of inclination. Dorsoversion of the acetabulum was present on CT images when the hemipelvis was 10° and 15° extrarotated and +20° inclinated.

CONCLUSION

In dogs CT is used to assess joint changes after pubic symphysiodesis and to detect joint laxity and cartilage damage for the diagnosis of hip dysplasia. Patient positioning is not standardized. Some authors place the dogs in dorsal recumbency and others in ventral recumbency. This could lead to different pelvic positioning relative to the scanning plane. Dorsal recumbency could mimic an inclinated pelvis, while ventral re-

cumbency a reclinated pelvic. This has been demonstrated to have a direct effect on the acetabular morphology both in CT images and on radiographs. In reclinated pelvis the acetabular coverage is overestimated, while in inclinated pelvis the acetabular coverage in underestimated. In this report acetabular angles (IAA and DARA) resulted affected by pelvic positioning in the way that the more the pelvic inclination the less the IAA and the more the DARA. As a result of this the more the inclination of the pelvis the worse the morphology of the acetabulum. In case of a reclinated pelvis, the slice cut involves a more cranial portion of the dorsal acetabular rim than in case of an inclinated pelvis. Moreover in a reclinated pelvis the slice cut involves the acetabular fossa. This is in agreement with the results of a recent report in which the AA differed significantly with small differences of pelvic tilt. Acetabular and pelvic torsional deformities associated with hip osteoarthritis are described in humans and recently reported in dogs. In dogs this pelvic abnormality is not well known. In this study IAA and DARA were affected by extrarotation of the pelvis (understood as torsional deformity) in the way that the more the extrarotation, the less the IAA and the more the DARA. As a result of this more the extrarotation, the worse the morphology of the acetabulum. External rotation of the hemipelvis on its long axis leads to a reduction of the dorsal acetabular coverage and predisposes to femoral head subluxation and could worsen joint instability. Dorsoversion of the acetabulum was seen only when the pelvis was inclinated. This points out that dorsoversion is dependent on the slice cut plane and on the positioning of the patient, as it is the COS on the radiographs. In conclusion, torsional deformities and pelvic positioning affect acetabular morphology on RX and CT images; so it would be necessary consider those variables to avoid mistakes in the evaluation of the acetabular cover. Three-dimension volume rendering of the acetabulum could be very useful in this case because it is independent of the scanning plane. On the other hand computations on 3D images are difficult and for this reason a standardised CT scanning protocol is needed to avoid misjudgement of acetabular angles and acetabular morphology. A proper scanning protocol should include standard slice thickness and slice selection for acetabular angles computation and it should consider pelvic inclination. The actual relevance of pelvic torsional deformities and dorsoversion is not well documented in dogs.

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