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KINEMATIC ANALYSIS OF THE GAIT IN HEALTHY COMMON BREED DOGS

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Abstract. In this study three-dimensional computer-asisted kinematic analysis was utilized to describe gait geometry in healthy common breed dogs for building a database which can be used as a model of musculoskeletal complex function. To determine the movement o scapulohumeral, elbow, carpal, coxofemural, femorotibial and tarsal joints in 3D space, opto- electronic system based on emission and reception of ultrasounds was used.

INTRODUCTION

The importance of treating kinematic analysis reside from the necessity of perfecting and using an objective, non-invazive method of diagnostic in the locomotory pathology of dog, wich can eliminate the subjectivity of the clinicians and wich will allow assesing the efficacity of different therapeuthical approaches.

In order for kinematic information to be helpful in diagnosis and post-therapeutic efficiency control, establish of a reference database is necessary.

Informations about these gait analysis techniques are quite scarce in the specialized literature.

Many authors (2, 4) consider that establish of gait symmetry in healthy animals is fundamental for an objective analysis of pathologic gait.

Kinematic variables offer objective, quantifiable informations about the locomotory apparatus parameters (3, 7, 8). By evaluating the temporal, linear and angular variables, the kinematic analysis determines the geometry of the movement without taking into account the determining forces (1, 3, 8).

Until now, most of the kinematic evaluations in animals have been done with videographic or opto-electronics systems, wich contain integrated software and hardware, based on emission and processing the infared or visible light rays. In this way the kinematic analysis gathers data from the markers placed on the animal´s body. These parametres will assesed from the quality point of wiew during movement. The result is a model of linear, temporal and angular measurements, wich describe the movements of a body segment or of the joint angles (2, 4, 5).

By placing the markers at the level of the main joints implied in locomotion, information recived by computer and then graphically represented in the coordinate system, can show major alteration of a joint angle wich are not visible to the naked eye (3, 8).

MATERIAL AND METHOD

Biologic material was represented by eight healthy common breed dogs, with weight between 12 – 15.5 Kg.

By radiographic examination and CT scan, the absence of osteo-articular disease was established in all dogs.

Because gait is a complex phenomenon, for an objective analysis we used a sophisticated method which allows simultaneous evaluation of multiple movements during a cycle of steps in a 3D space.

Kinematic analysis of gait was made in CIDUCOS lab of Politehnic Institute Timisoara using Zebris CMS-HS 3D analysis system.

This is a 3D kinematic analysis system used also in human medicine , utilises as a working principe the emmision and reception of ultrasounds. By using active sensors, technically represented by three ultrasonic microphones places at 120º the time needed for the ultrasound to reach from them to the ultrasound emmiter is measured, thus realising the tridimensional coordinates of thee sensor and of the segment to be analysed.

To record the movement of forelimb joints, in each dog active markers were applied on both thoracic limbs, at half of the distance between the point of scapulohumeral and elbow joints from the left and then right side. The markers were applied on the limbs with the dog standing. After active marker fixation, points needed for obtaining the geometric model of the limb were electronic marked with the help of an electronic pointer. Those points are: greater tubercule of the humerus, epicondyles of the humerus, ulnar styloid process, carpo-radial bone, carpal accesory bone, dorsal face of distal phalanx.

In hindlimbs, active markers were applied at half of the distance between coxofemoral joint and stifle, and electronic marking was applied on greater trochanter, of the femur, condyls of the femur, malleolus of the distal tibia, malleolus of the distal fibula, fibular tarsal bone, dorsal face of distal phalanx.

After electronic marking, dogs where walked with constant speed in test space for a lenght of 6 meters. Recordings in which the speed was variable or dogs deviated from direction where eliminated. The test space was made at least two times on each side.

By statistic analysis, the following kinematic variables were determined in hindlimb: flexion-extension of hip, stifle and tarsal joints .

Kinematic variables recorded in forelimb were: flexion-extension of scapulohumeral, carpal and elbow joints.

RESULTS AND DISCUSIONS

Scapulohumeral joint on chart (fig. 1) presents a small flexion movement during stance phase, with the initiation of extension movement during first phase of swing phase.

Two peeks of extension movement were observed, with a maximum extension which precedes the stance phase and one with smaller intensity during stance phase. DeCamp and co-workers 1993 (4), observed the same graphic representation of scapulohumeral joint movement.

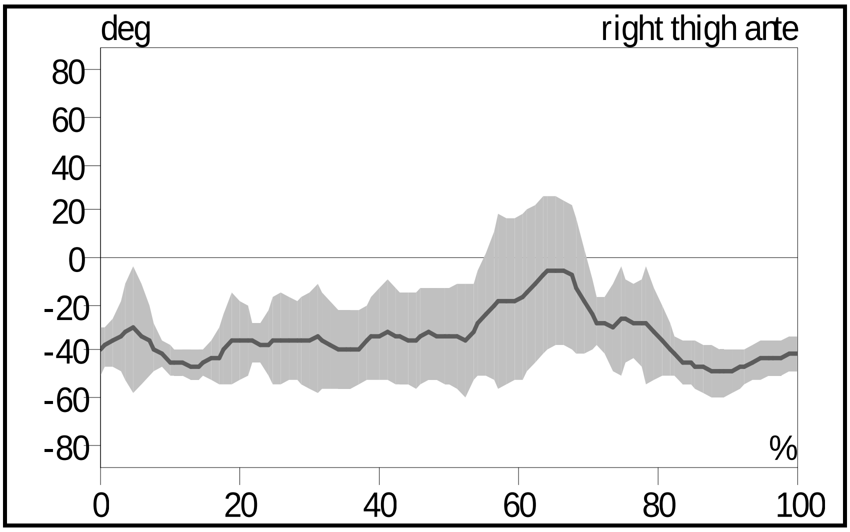

Fig.1. Graphs of flexion and extension movement of the
right scapulohumeral joint

On graphic representing flexion-extension movement of elbow joint (fig.2), a short period of flexion during early stance phase, followed by a movement of maximum extension during stance phase. At the end of stance phase a movement of quick flexion is initiated, followed by a quick extension during swing phase. Two peaks of maximum intensity were observed, one during late stance phase and another during late swing phase. Peaks of extension movement are almost equal. Results are similar with those presented by specialty literature (4, 6).

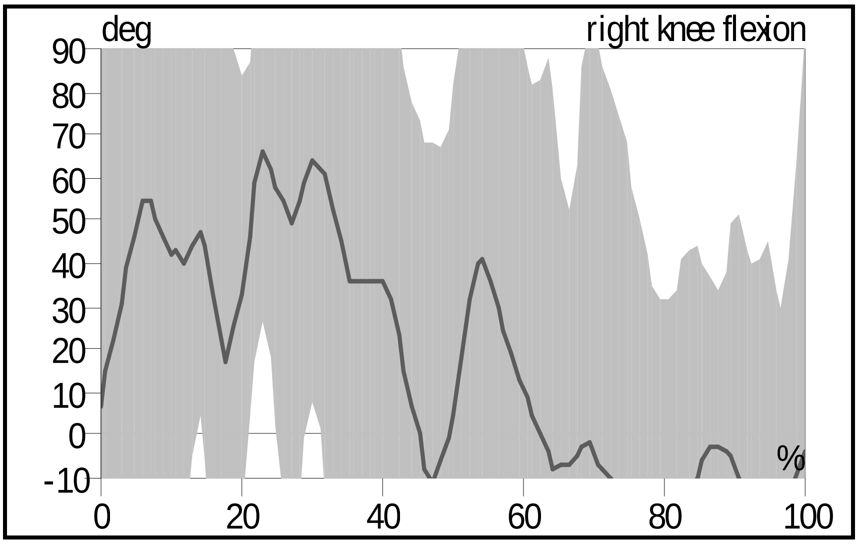

Fig. 2. Graphs of flexion and extension movement of the
right elbow joint

Carpal joint is in graphic (fig. 3) characterised by an extension movement during stance phase. Flexion is initiated at the end of stance phase with the presence of two peaks of the maximum flexion followed by an extension movement initiated during early swing phase.

DeCamp and co-workers 1993 (4, 6), observed only one peak of maximum flexion during early swing phase of carpal joint.

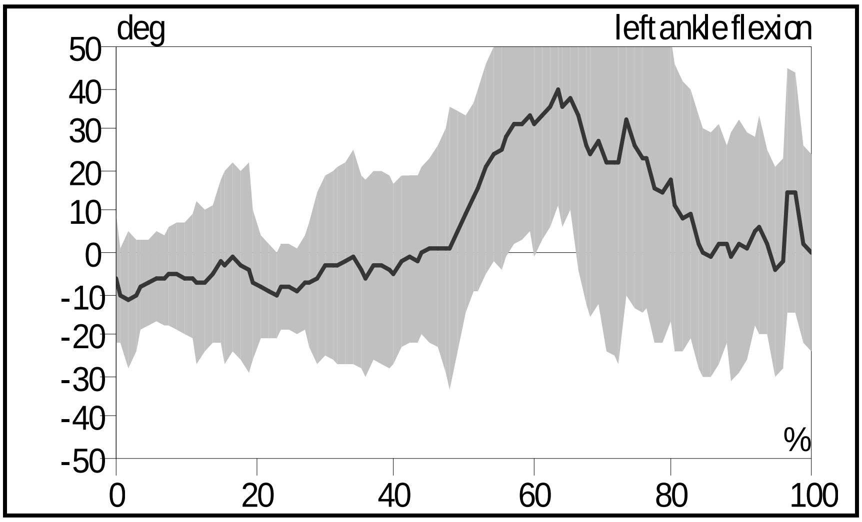

Fig. 3. Graphs of flexion and extension movement of the right cubital joint

Hip joint is graphic (fig.4) represented during stance phase by an light extension move, with only one peak of maximum extension. This move is followed by flexion in swing phase.

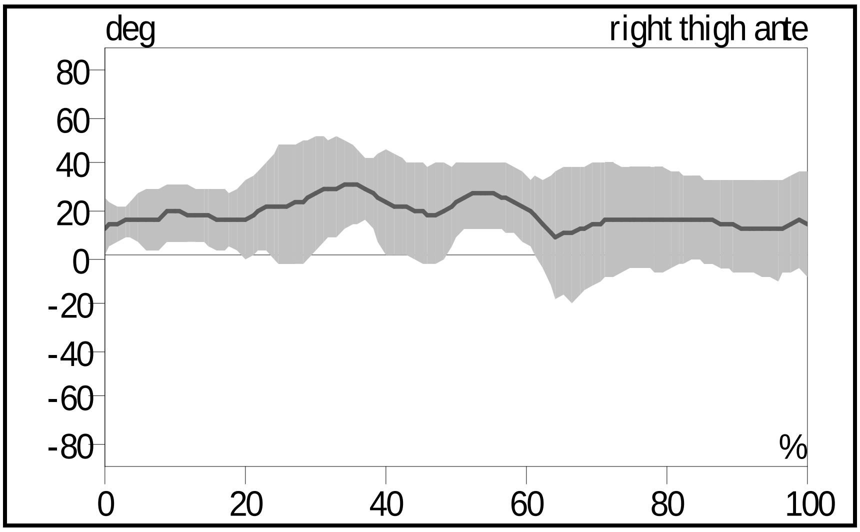

Fig. 4. Graphs of flexion and extension movement of the right coxofemoral joint

The stifle joint (fig. 5) realizes a gradual flexion movement during stance phase, with the start of quick flexion movement during the end of this phase, followed by quick extension during swing phase. A single maximum extension peak is observed at the end of swing phase.

DeCamp and co-workers 1993 (4) observed two peaks of extension movement in case of stifle joint in Greyhound dogs, first, a peak of maximum extension which precedes stance phase, and the second one, of lower intensity, during stance phase.

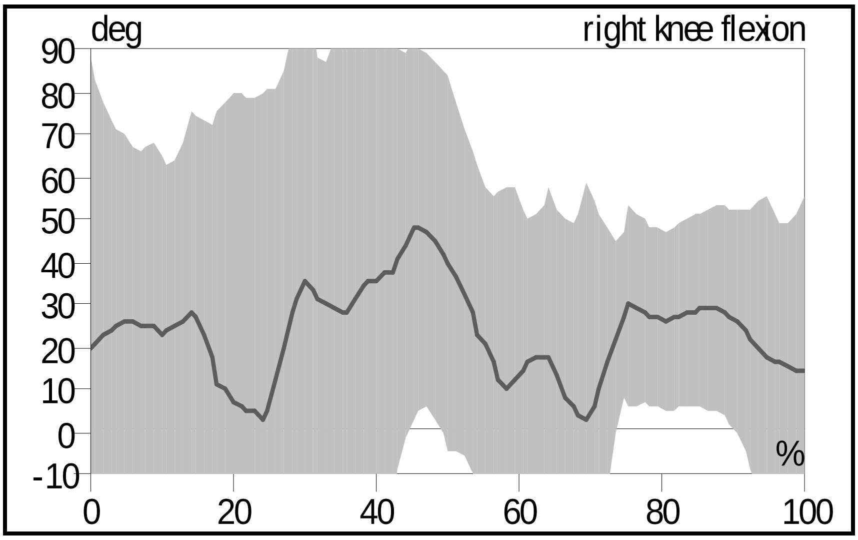

Fig. 5. Graphs of flexion and extension movement of the
right femorotibial joint

Tarsal joint presents on graphic (fig. 6) movements that are similar to stifle joint with the exception that extension amplitude in the late stance phase is lower at this level. Initial is flexed in the early stance phase, followed by extension in the rest of the phase. The quick flexion movement is initiated at the end of the stance phase, being followed by quick extension in the middle of swing phase. At the end of the two phases of the gait, two maximum extension peaks can be observed.

This results coincided with the one mentioned in speciality literature excepting the fact that the maximum extension peaks, are almost equal (4, 6).

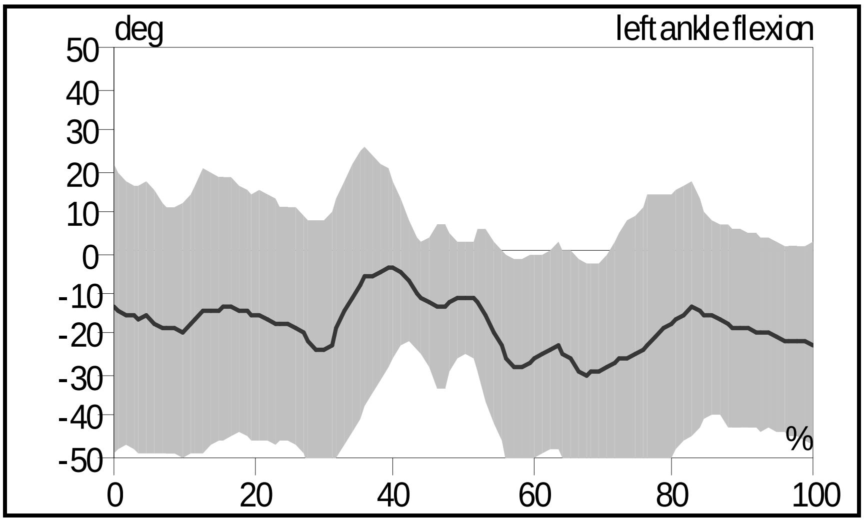

Fig. 6. Graphs of flexion and extension movement of the right tarsal joint

CONCLUSIONS

Computerised three-dimensional kinematic analysis of the gait proved to be a viable technique which allows simultaneous evaluation of multiple movements during gait

Database obtained in this study can be used for comparison with the data obtained from animals suffering osteo-articular system diseases or with the one obtained after treatment, to evaluate post-therapeutic results.

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