# MEASUREMENT OF JOINT ANGLES IN A CANINE MUSCULOSKELETAL MODEL: DIRECT KINEMATICS VERSUS INVERSE KINEMATICS

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## Introduction

Musculoskeletal modeling and simulations could provide insight into the physiologic and pathologic motion patterns of animals. Furthermore, it makes scientists capable of evaluating the effects of different orthopedic surgeries on gait patterns or investigating the effectiveness of different prostheses by using these models [1,2]. We generated a 3D canine musculoskeletal model to simulate normal gait in sound dogs. The aim of our study was to 1) develop a workflow for musculoskeletal modelling of dog movements and 2) compare the dog's joint kinematics obtained by direct versus inverse kinematics to test the model's validity.

## Methods

We used 3D motion capture data of a sound Labrador dog from our previous study. An anatomically valid 3D model of a canine skeleton, which was designed for educational purposes, was used as our base model. This model was imported to nmsBuilder software for 3D modeling. After the definition of the bodies, coordinates, required markers, joints, and muscles a 3D model was created and imported to OpenSim software to perform inverse kinematics based on the acquired motion capture data. The angles of the shoulder, elbow, carpal, hip, stifle, and tarsal joints were calculated via direct kinematics (DK) and inverse kinematics (IK) [3]. Calculation of the angles were based on three markers located proximal to the joint, near/on the center of the rotation of the joint and distal to the joint in the sagittal view (Figure 1). The obtained joint angles were finally smoothed by a Butterworth low-pass filter with a cutoff frequency of 6 Hz.

## Results

Difference in joint range of motion between the DK and IK approach was 6.4° for the shoulder, 8.5° for the elbow, 18.4° for the carpal, 3.3° for the hip, 0.7° for the stifle and 2.4° for the tarsal joints. These results will be extended by including more dogs in our study and the final result will be statistically analyzed to present the differences in congress.

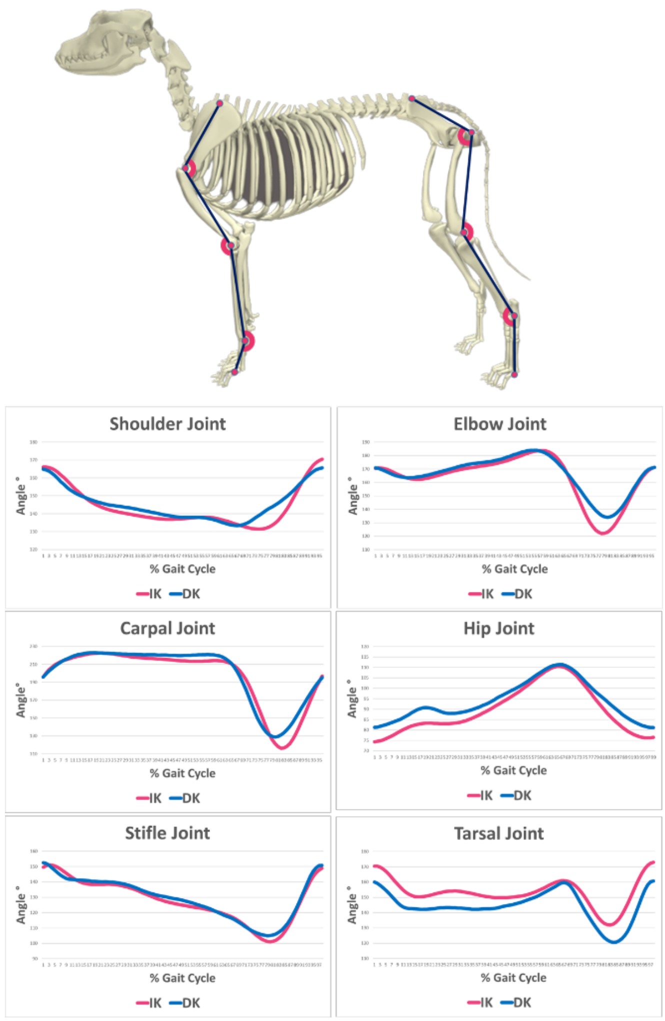


*Figure 1: Illustration of the markers and vectors used for calculation of the joint angles in a gait cycle.*

## Discussion

Validation of the musculoskeletal models by comparing the DK and IK is an important step for the application of these models, which can give scientists insight into the model development and errors of DK such as skin displacement.

## References

1. Andrada, Emanuel, et al. American journal of veterinary research 78.7: 804-817, 2017
2. Stark, Heiko, et al. Scientific reports 11.1: 1-13, 2021.
3. Kainz et al. Journal of biomechanics 49.9: 1658-1669, 2016.