DEVELOPMENT OF A MUSCULOSKELETAL MODEL FOR THE EVALUATION OF THE DOG'S SPINAL BIOMECHANICS

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Introduction

Some of the most common problems and diseases in dogs are related to the spine. Like humans, dogs are subject to herniated discs, vertebral fractures and degenerative diseases, and in most cases surgery is required [1].
The use of a 3D musculoskeletal model could be very useful to study and define how to intervene in case of necessity. Up to now, there is not a valid model of large dogs, because most of the studies are done on small dogs, as beagles [2]. Therefore, the aim of my work is based on the development of a 3D musculoskeletal model of a dog's spine.

Methods

I started my work from the analysis of CT scans of a German Shepherd dog provided by Prof. Vandeweerd, from University of Namur, and Dr. Kayser, from CHU UCL Namur.
I started by segmenting the complete spine of the dog with 3D Slicer software, obtaining every single vertebra. I also added other bones of the body that would be useful for my studies, in order to have a complete model.
After this, I introduced the most important muscles that allow the dog's body to move and recreate some basic movements, using Opensim software.
Starting from the study of the dog's anatomy, I defined which muscles are most involved during movement. The model will obviously be simplified compared to the dog's real body because there are too many muscles involved, so I am concentrating on those most implicated and necessary to perform the movements.
I am currently completing my work by looking for some kinematic data of the dog's motions to recreate and obtain a model close to reality.

Results

Using the Opensim software, I want to reproduce the movements performed by the dog based on the available data to have a correctly functioning model of a German Shepherd dog. The completed model will then be characterised by the most important muscles of the spine, also connected to the fore and the hindlimbs.
This will allow simulations very similar to reality to be obtained and canine movements to be studied.

Discussion

Since large dogs have many spinal problems and there are no musculoskeletal spine models available at the moment, my work will be very useful.
This model will be able to help vets as it will provide information that can be necessary before surgery, so that they can work in the best possible way, minimising the risk of failure.
In addition to being a support for veterinarians, it will also be helpful for the engineers themselves. Indeed, when a spinal fixator is created, it is important to test if what has been designed can be fitted correctly on the spine and if it can perform all the functions for which it has been designed.
A model like this will be able to define the correct points in which the fixators should be placed, simulating their behaviour on the dog's body and making it possible to understand which forces need to be applied to avoid damage to the skeleton, encourage bone regrowth and help the dog in its movements.

References

1. https://www.animalpedia.it/malattie-della-colonna-vertebrale-del-cane-cause-e-trattamento-3968.html
2. Stark, H., Fischer, M.S., Hunt, A. et al. A three-dimensional musculoskeletal model of the dog. Sci Rep 11, 11335 (2021)