v. 4, n. 12, 2024

Journal of
Agricultural
Sciences
Research

Acceptance date: 19/09/2024

PROTOTYPE OF A CANINE EXOSKELETON MADE BY THE SPYCK PROJECT

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Abstract: This study focuses on developing and evaluating an exoskeleton adapted for elderly dogs with orthopedic problems, with the aim of improving the mobility and quality of life of dogs affected by sarcopenia and other conditions related to aging and locomotion. The hypothesis is that the exoskeleton can significantly improve mobility and reduce pain, by performing movements that depend on the animal's own physical strength, and so the exoskeleton would be part of that strength for the animal, providing physiotherapeutic support over time, as well as being comfortable and applicable to different sizes and breeds of dogs. The study follows an experimental design with a single case, to test the exoskeleton prototype. The prototype was developed through several stages, including 3D modeling and printing of the parts, assembly and testing on a mannequin. The process of building the exoskeleton involved creating a mold of the model, 3D modeling using software such as Blender and Inventor, and printing the parts with the Ender3 3D printer. The parts were then assembled and adjusted to ensure comfort and functionality. As yet, the exoskeleton has not been tested on the model to assess its effectiveness and adjust the design as necessary.
Keywords: Exoskeleton; Prototype; Locomotion.

INTRODUCTION

Aging can be defined as a dynamic and progressive process, characterized by a series of morphological, functional and biochemical changes that occur over time in the body. These changes affect various systems, such as the cardiovascular, musculoskeletal, nervous, among others. Just like humans, dogs also go through an ageing process throughout their lives. Canine ageing is a natural and inevitable phenomenon, but the speed and effects of this process can vary according to the dog's breed, size and even lifestyle.

The changes in joints and mobility caused by ageing result in pain and difficulty moving, which has a significant impact on the quality of life of animals. The ability to move, play, socialize and even perform basic daily activities, such as climbing stairs or getting up, becomes very difficult. The reduction in muscle mass due to advanced age is a common change in the body composition of elderly dogs and is of great clinical and functional importance. This loss of muscle and consequent muscle function is described by the term sarcopenia. This condition is characterized by a decrease in the quantity and quality of muscle tissue, which can lead to a reduction in muscle strength, endurance and overall physical function.

The central problem of the research is the significant loss of mobility and quality of life in elderly dogs due to sarcopenia and other conditions associated with ageing. Although there are palliative treatments and management measures that can alleviate some symptoms, there is still a need for innovative and effective solutions to improve the mobility and well-being of these animals significantly.

The relevance of this research lies in the search for technologies that can offer a substantial improvement in the quality of life of elderly dogs. The prototype of an exoskeleton adapted for dogs can not only help mitigate the negative effects of ageing, but also provide a practical and affordable solution for dog owners looking to improve the health of their animals. This study has the potential to open up new perspectives in veterinary geriatric and orthopedic care and could influence future technological advances in the field.

The aim of this article is to show the prototype of an exoskeleton for elderly dogs, focusing on how this technology can help mitigate the negative effects of aging, especially those related to mobility and sarcopenia. Using the case of Wendy, a 17-year-old *ShihTzu* puppy, as an example, the article will show the stages of construction of the exoskeleton prototype.

STUDY HYPOTHESIS

The main hypothesis of the study is that the use of the exoskeleton will result in a significant improvement in the mobility of elderly dogs, allowing them to carry out daily activities more easily. It is also hoped that the exoskeleton will provide a noticeable reduction in the pain associated with mobility, resulting in an increase in the quality of life of elderly dogs. In addition, the construction of the exoskeleton with light and durable materials is considered feasible and effective, guaranteeing comfort and functionality for the user dogs. Finally, the case study with Wendy aims to demonstrate that the exoskeleton can be adapted for different breeds and sizes of dogs, demonstrating its applicability and potential for wider use.

With these objectives and hypotheses, this study seeks to make a significant contribution to the field of veterinary geriatric care, offering an innovative and practical solution to improve the lives of elderly dogs.

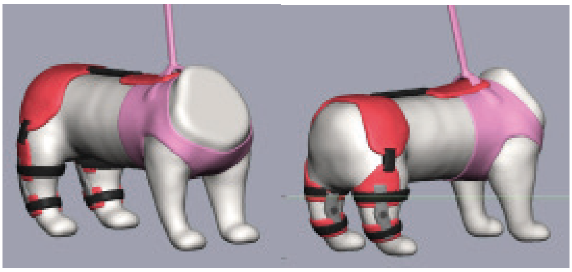
STUDY DESIGN

The design of this study is experimental, focusing on the construction and evaluation of an exoskeleton for elderly dogs. The study will use a single-case method, where Wendy, with her guardian's permission, will be fitted with the exoskeleton prototype.

Exoskeletons can be a valuable tool in the treatment of sarcopenia and spondylosis, offering mechanical support that facilitates physical activity and helps to strengthen muscles. For Wendy, a well-designed exoskeleton can provide greater independence and comfort, allowing her to walk with less effort and stay active for longer. In addition, the device can provide extra assistance during movements, relieving the load on muscles and joints and compensating for muscle weakness when necessary.

DESIGNING THE EXOSKELETON PROTOTYPE

The images below show the 3D design of the exoskeleton prototype. Let's take a look:



Figures 1 and 2: 1st phase of modeling the orthosis for the exoskeleton.(Source: archive Sulamita da Silva's staff Barros).

MATERIALS USED

The materials used were: 20und. Philips conical head M4 X 15mm, 20und. M4 parlock nut, 8und. Repeat M5 x 10mm, 1und X size chest strap, 1und. Aluminum plate 70 x 80 x 4 mm, 5m PT polyester strap, 8und. PT male/female clip and 500g of PLA - BR filament.

EXOSKELETON CONSTRUCTION

The project in question was carried out in 26 stages, as follows:

1. Wendy's mold - the mold was made with plastic film, wrapped around Wendy in several layers and cut with scissors from the caudal region to the cervical region, after which the space was filled with cotton and covered with crepe tape to hold it in place. Once completed, the measurements were checked on the mannequin compared to the animal and sent to São Paulo so that the engineering students could transfer the measurements to the research;

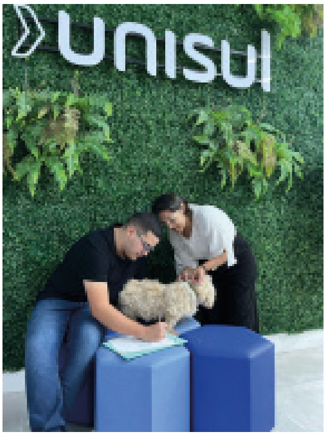


Figure 3: Wendy's measurement process for creating the mannequin used in the development of the exoskeleton. (source: Personal archive of Gilson Gervásio Junior).

Figure 4: Mold in plastic film, wrapped in layers of (source: Graziela Viviane Pereira's personal archive).

2. When the mannequin was purchased, a search was made on the internet for an STL model of a dog with a body similar to Wendy's in order to speed up the modeling process and avoid having to draw the animal from scratch.

3. Correction of the mesh in the Meshmixer of the file found so that there are no flaws in the 3D modeling;

4. Using Blender to transform the 3D model found on the web into a 3D model of Wendy based on the measurements taken from the physical mold;

5. Once Wendy's 3D modeling was complete and the measurements were as close as possible to Wendy's, we began the 3D modeling of the orthosis using

Blender, ensuring that it was perfectly placed on Wendy's body and taking into account the space between the orthosis plates and Wendy to insert fabrics and foams for protection and comfort when using the orthosis. When modeling, it was also necessary to take into account the use of the breastplate to help with the use of the orthosis;

6. Mesh correction using Meshmixer of the files created in Blender to ensure that there are no errors in the 3D printing of the parts;

7. Measurement on the modeled orthosis of the positioning of the joint parts, with a much more precise and mechanical assembly, so instead of using free modeling software, parameterized software was used;

8. Modeling the joint parts using Inventor;

9. Assembling the joint assembly using Inventor;

10. Exporting the orthosis files in Blender to STL;

11. Exporting the joint STL files in Inventor.

12. Importing the orthosis STL files into CURA to slice the parts; 13. Filling in the printing parameters taking into account the use of PLA filament and the Ender3 printer in the Cura software, this step will directly influence the printing of the part, whether it's the finish or the fit of the part;

14. After correct slicing and insertion of the supports as required, the 3D printing stage begins;

15. To start 3D printing, the print base must be aligned; 16. 3D printing begins;

17. Once the 3D printing is complete, the printing supports are removed and the pieces are finished with sandpaper;

18. Purchase of aluminum sheet in the thickness of the joint parts; 19. Sending the files and the aluminum sheet for water jet cutting;

20. Riveting of the joint parts cut for assembly, chosen because they are articulated parts, if a nut or bolt were used they would come loose. This makes it a non-detachable fastener;

21. Fitting the fixing straps into the sockets of the orthosis plates;

22. Screw the joint assembly onto the orthosis;

23. Fitting the orthosis to the chest;

24. Test of the finished orthosis in Wendy's mold;

25. Check and adjust as necessary;

26. I'm sent for testing at Wendy's.

CONCLUSION

The study aims to demonstrate the effectiveness of an exoskeleton designed to improve the quality of life of elderly dogs, as exemplified by the case of Wendy. The completion of the development and testing of the prototype should provide valuable insights into the feasibility and benefits of this technology for dogs with mobility difficulties due to ageing.

The expected results include a significant improvement in the mobility of elderly dogs, a noticeable reduction in the pain associated with locomotion and an overall increase in quality of life. In addition, the research has the potential to expand the use of exoskeletons to different breeds and sizes of dogs, offering an innovative and practical solution for owners looking to improve the health and well-being of their elderly animals.

The construction and testing of the exoskeleton will also contribute to the advancement of geriatric and orthopedic veterinary care technologies, showing the applicability and effectiveness of this approach. The research opens up new perspectives for the development of adaptive solutions for the care of dogs in old age and could influence future advances in the field, offering a viable alternative for increasing the independence and comfort of elderly dogs.

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