Veterinary bone marrow aspirate models

Date: 10/17/2024

Client: Dr. McLean Gunderson

Advisor: Prof. Randy Bartels

Team:

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- Helene Schroeder - Co-Leader, BSAC - hschroeder4@wisc.edu
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Problem Statement

Veterinary professionals commonly collect bone marrow aspirates from three main sites in dogs and cats: the iliac crest, the trochanteric fossa, and, mostly commonly, the proximal humerus. Currently no veterinary bone aspiration models exist for students to practice on, requiring the use of cadaver dogs. Cadavers can only be used for about 5-10 insertions of the Illinois bone marrow biopsy needle per site, but does not contain live bone marrow that can be collected. This project aims to create a low-cost 3D anatomically correct model of the humerus with relevant soft tissue structures, mimics the consistency and structure of the bones, and allows for insertion of "bone marrow" for collection, allowing veterinary students to practice the skill of bone marrow aspiration.

Brief Status Update

This week the team worked on scanning the bones provided by Dr Gunderson in the Makerspace. We were able to obtain .stl files that will be used to create a CAD model of the design and subsequent 3D printing.

Difficulties / advice requests

We are having some difficulties finding exact quantitative literature values of various bone characteristics to compare the materials to. This makes it hard to do testing and compare our results to research.

Major team goals for the next week

- Begin working on the CAD model of entire bone structure
- Begin working on the CAD model for the replaceable component
- Finalize fabrication plans and order any outside materials needed

Next week's individual goals

- Avery
    - Finish any post processing needed on the 3D scans in Blender
    - Help teammates get SolidWorks set up and provide examples/tutorials for practicing skills
    - Continue research/brainstorming to finalize the materials needed for the muscles and shoulder socket
- Helene
    - Work on post processing the 3D scans.
    - Brainstorm ideas on what to present at the Show and Tell meeting in November.
- Anya
    - Get Solidworks for computer and help to edit the STL files from 3D scanner
    - Brainstorm materials for the final model, specifically look at potential shoulder joints
- Ella
    - Set up SolidWorks and become familiar with the program
    - Continue looking at materials for the muscles
    - Continue brainstorming ideas for the final model
- Ellie
    - Setup Solid works and familiarize myself with the system
    - Continue researching muscle and ways to attach the skin

Timeline

Task	Sept				Oct				Nov					Dec	
	6	13	19	27	4	11	18	25	1	8	15	22	29	6	11
Project R&D															
Empathize	X	X													
Background…		X	X	X	X	X									

Prototyping						X	X								
Testings															
Deliverables															
Progress Reports	X	X	X	X	X	X	X								
PDS			X												
Prelim presentation					X										
Prelim Report						X									
Final Poster															
Final Report/Notebook															
Meetings															
Client		X		X											
Advisor	X	X	X			X									
Website															
Update	X	X	X	X	X	X	X								

Filled boxes = projected timeline
X = task was worked on or completed

Current design

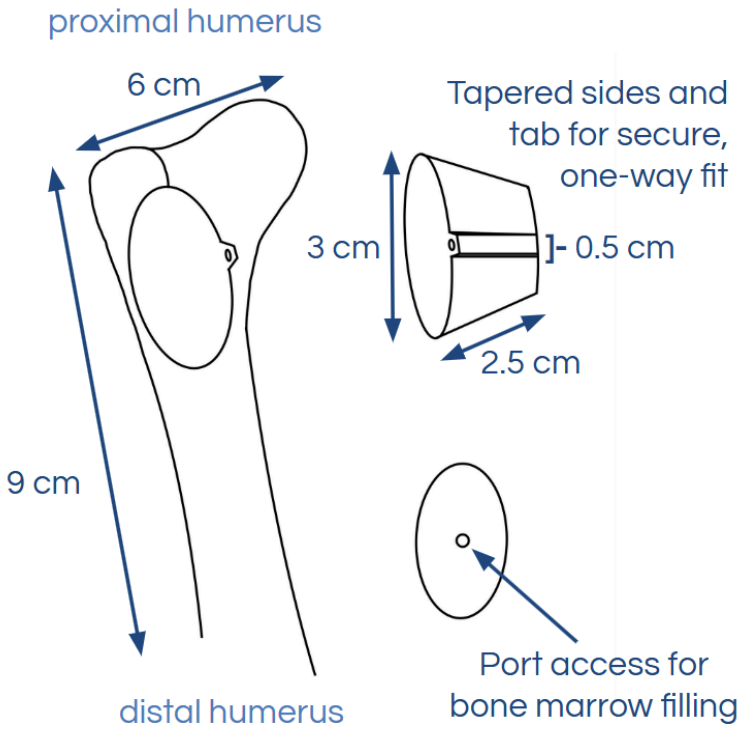

Figure 1: Drawing of the Slide Method of attachment

The proposed final design features the Slide Method of attachment for the design of the replaceable component. The oval section will be hollow to allow the client to fill the simulated bone marrow fluid into the port in the base of the design. The tab allows the user to easily orient the removable section correctly and slide it into place. Both the replaceable component and the rest of the bony structures (scapula, humerus, and fixed elbow) will be 3D printed using PLA. Surrounding the bones will be relevant musculature made from soft silicone which will further help the replaceable component remain in place when the needle enters and exits. The simulated skin, fabricated by the client out of neoprene and pourable silicone, will be affixed over top and will help to hold the musculature and bones in an anatomical position.

Previous week's goals and accomplishments

- Team
    - Began the 3D scanning process at the Makerspace of the bones given to us by Dr. Gunderson and Dr. Schmidt.
- Avery
    - Completed online 3D scanning training and set up an in person help session to begin the fabrication process.
    - Made a testing plan to obtain quantitative values for the strength of our 3D printed bone compared to a real humerus.
    - 3D scanned bones with the help of Makerspace staff.
- Helene
    - Continued research for bone characteristic values and the force required to puncture cortical bone with a needle.
    - Worked with the team to begin 3D scanning and fabricating the model.
- Anya
    - Brainstormed testing ideas to asses the pressure it takes to aspirate 3D printed samples with variable in fills
    - Did research on cortical bone structure and try to figure out how to mimic this
    - Helped with 3D scanning on selected bones to create STl files.
- Ella
    - Created ideas for how the complete model will look and be arranged
    - Worked with the team to begin 3D scanning the bones and creating a model
    - Continued researching materials for muscle and bone models
- Ellie
    - Researched bone density and help to figure out the force required to puncture through the model/bone
    - Kept track of expenses and help the team fabricate the model

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Avery Schuda	10/16/24	-Brainstormed ideas for muscle and shoulder joint components -Worked with Makerspace staff and team to 3D scan bones	4	4	37
Ellie Kothbauer		-Went to Makerspace with the team to 3D scan our bones -continued to add to labarchives with ideas	4	4	26
Anya Bergman	10/16	- Went to makerspace with team to 3D scan the selected bones - brainstormed on ideas for skin attachment	3	3	23
Helene Schroeder	10/16	- 3D scanned bones at the Makerspace with the team. - Research skin and muscle properties.	3	3	25
Ella Cain		-Went to the Makerspace with the team to 3D scan the bones -Created another concept for the final design in LabArchives	4	4	27

Materials and expenses

Item	Description	Manufac-turer	Mft Pt#	Vendor	Vendor Cat#	Date	#	Cost Each	Total	Link
Category 1										
Material test swatches	PLA, ABS, and PETG test swatches	UW Makerspace		UW Makers pace		9/26/ 2024	3	0.17	$0.51	
									$0.00	
Category 2										
									$0.00	
									$0.00	
								TOTAL:	**$0.51**	