Veterinary bone marrow aspirate models

Date: 11/14/2024

Client: Dr. McLean Gunderson

Advisor: Prof. Randy Bartels

Team:

- Avery Schuda - Co-Leader - aschuda@wisc.edu
- Helene Schroeder - Co-Leader, BSAC - hschroeder4@wisc.edu
- Anya Bergman - Communicator - ambergman2@wisc.edu
- Ella Cain - BWIG - elcain2@wisc.edu
- Ellie Kothbauer - BPAG - ekothbauer@wisc.edu

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 met with a design advisor from the Team Lab to continue working through the issues with converting the.stl to a workable CAD file to create the replaceable component. We received the silicone and joints we ordered to continue testing and fabrication. We printed a set of unmodified bones to be able to continue working on the other components of the model besides the replaceable component.

Difficulties / advice requests

We are continuing to have issues with converting the .stl to a workable CAD file, as the Team Lab consultation did not yield a successful solution. We are continuing to look for a solution and as a last ditch effort can manually carve the piece out for the replaceable component, but will lose accuracy.

Major team goals for the next week

- Finish fabrication before leaving for Thanksgiving break.
- Finalize testing plans.
- Begin working on final deliverables.

Next week's individual goals

- Avery
    - Brainstorm methods to obtain quantitative testing data.
    - Continue to work on CAD model and fabrication.
    - Make plans for assembly and documentation.
- Helene
    - Continue the fabrication process with the team.
    - Plan the final schedule for making the final report and presentation.
- Anya
    - Work on CAD model and finalize design.
    - Work on fabrication and methods for assembly.
    - Work on getting quantitative testing.
- Ella
    - To help with the printing of the bone models.
    - To continue looking for a way to edit the CAD model.
    - Find an adhesive for the pseudo-skin and muscle.
- Ellie
    - Help work with the model bones and figure out ways to carve out the portion
    - Brainstorm ways to attach the silicone, and make it look muscle-like
    - Try and find ways to work with the CAD model

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	X	X	X					
Testings									X	X					
Deliverables															
Progress Reports	X	X	X	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				X					
Website															
Update	X	X	X	X	X	X	X	X	X	X					

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

Current design

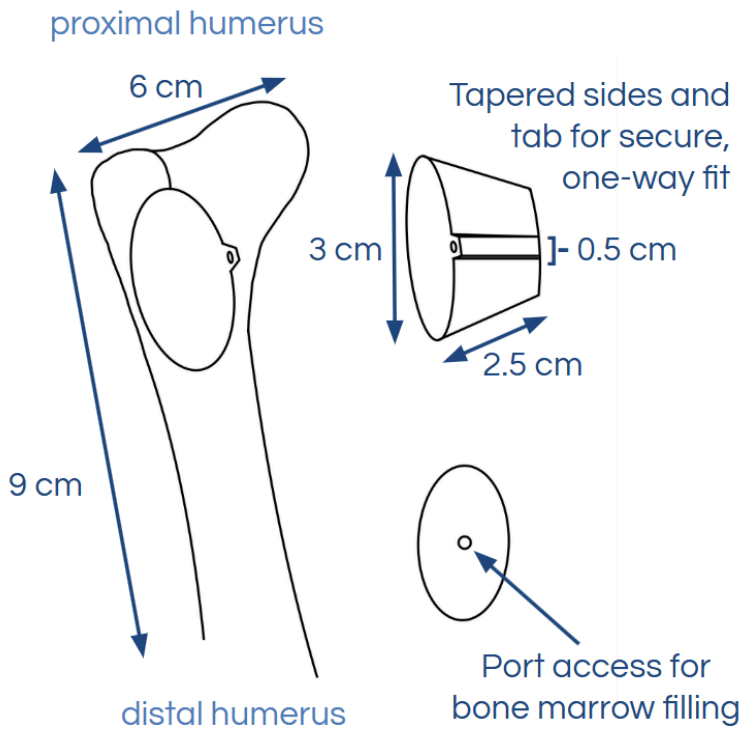

Figure 1: Drawing of the Slide Method of attachment

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
  - Ordered remaining materials for testing and fabrication.
  - Continued work on the CAD models.
  - 3D printed further iterations of the bones for testing.
- Avery
  - Continued working on the CAD model of the bones.
  - 3D print test bones from CAD.
  - Brainstormed about base and method of attaching the skin and muscle.
- Helene
  - Determined how to attach skin/muscle to the model.
  - Looked into testing methods for what prototype materials we have so far.
- Anya
  - Helped with the CAD model of the bones.
  - Figured out an attachment method for the shoulder joint.
  - Tested the new U-joint out for the shoulder to determine if it will be the best fit possible for the project.
- Ella
  - Went over advice given from the show-and-tell presentation about muscle and skin attachments
  - Determined the material for muscle
- Ellie
  - Looked into methods of attachment for the muscle, and the edited portion
  - Worked on Autocad skills and how to carve out the removable portion

Activities

Name	Date	Activity	Time (h)	Week Total (h)	Sem. Total (h)
Avery Schuda	11/14/24	-Further research on how to convert .stl to workable CAD file -Brainstormed for base and attachment method for skin and muscle	3	3	57

Ellie Kothbauer		-Did research on muscle like materials - Worked on autocad skills and brainstormed ways to remove the detachable site	2	2	39
Anya Bergman		-Met with a mentor to get help with CAD model -Print out bone set for working on assembly - Brainstormed ways to edit the CAD and attach the joint	3	3	38
Helene Schroeder		- Worked on drafting potential testing protocols for when we begin testing the replaceable component.	2	2	35
Ella Cain		-Went with Anya to the Design Lab to receive help on editing the STL file. -Created an idea for attaching skin and muscle. -Helped to 3D print the forelimb bones.	3	3	42

Materials and expenses

Item	Description	Manufacturer	Mft Pt#	Vendor	Vendor Cat#	Date	QTY	Cost Each	Total	Link
Category 1										
Material test strips	We printed out strips of PLA, ABS, and PETG at different densities to see with materials work the as a bone replication	Makerspace 3d printers	.	UW madison Makerspace		9/26/2024	3	$0.17	$0.51	

Right Humerus PLA print	We printed out a Right Humerus out of Bambu Labs PLA Matte		7747593925	Makerspace Design Building		10/31/2024	1	$1.38	$1.38	
Right Leg Full Print	We printed out forelimb, humerus and Scapula	Makerspace		Makerspace Design Building		11/14	1	$4.18	$4.18	
4 Red silicone rubber sheets	4 1ft by 1ft sheets of Red silicone sheets were ordered for muscle replica	Tlence Store		Amazon		11/7/2024	1	$23.99	$23.99	
Universal joint (for shoulder joint)	1 ⅜ in long, overall large, chrome	Westword	54PR13	Grainger		11/5/2024	1	$17.08	$0.00	
								TOTAL:	**$25.88**	