

Designing a Regenerative Implant to Help Heal Critical Bone Defects



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Background

What is the problem we are trying to solve?

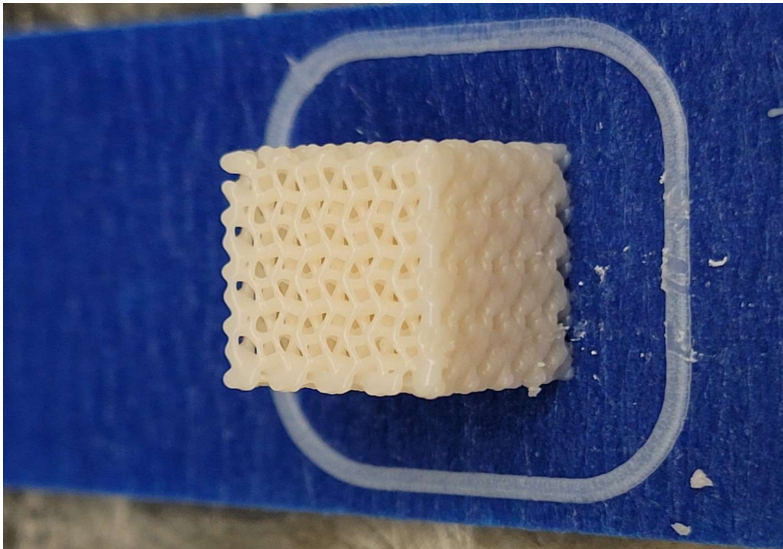
- Humans, dogs, and other animals often must have substantial sections of bone removed due to bone cancer and trauma
- Often results in limb loss

What is the current solution?

- Plates and screws are surgically implanted to partially retain skeletal structure and support normal loads
- Usually remains in the body permanently



Our Current Design



The Scaffold

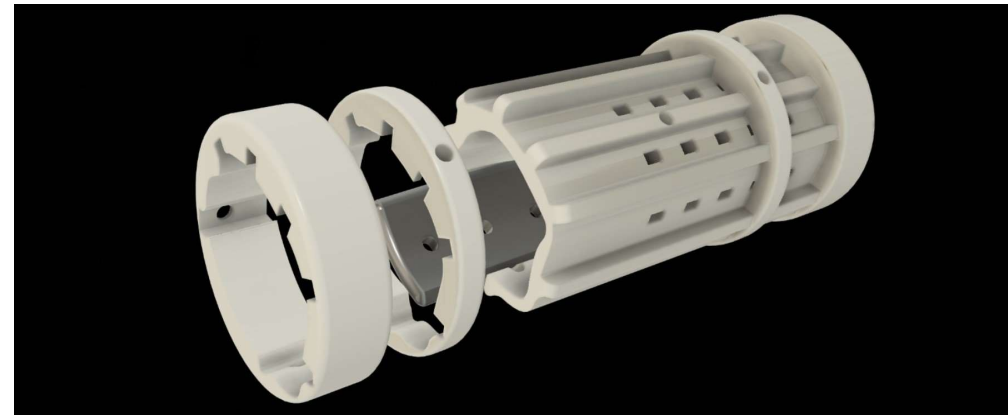
- Facilitates the regeneration of natural bone
- “Gyroid” topology
- Varies from 60 to 80% porosity
- Currently printed with hydroxyapatite (HAp)

Plate (gold standard)

- Stainless steel, supports the loads

Sleeve & Cuff Prostheses

- Sleeve contains/protects the bioactive hydroxyapatite (HAp) scaffold
- connected to plate
- Held together by surgical screws and cuffs
- 3D printed using polycaprolactone (PCL).



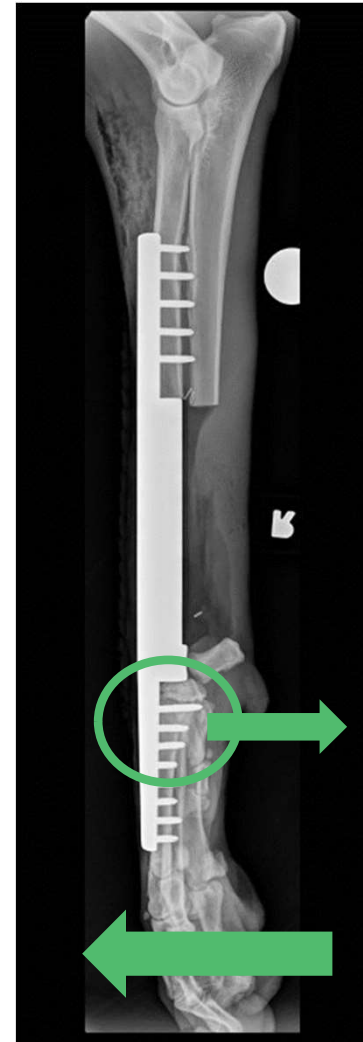
My Project

What is the problem?

The screws fastening the plate loosen and fail due to repetitive movement under load when the paw bends in normal gait.

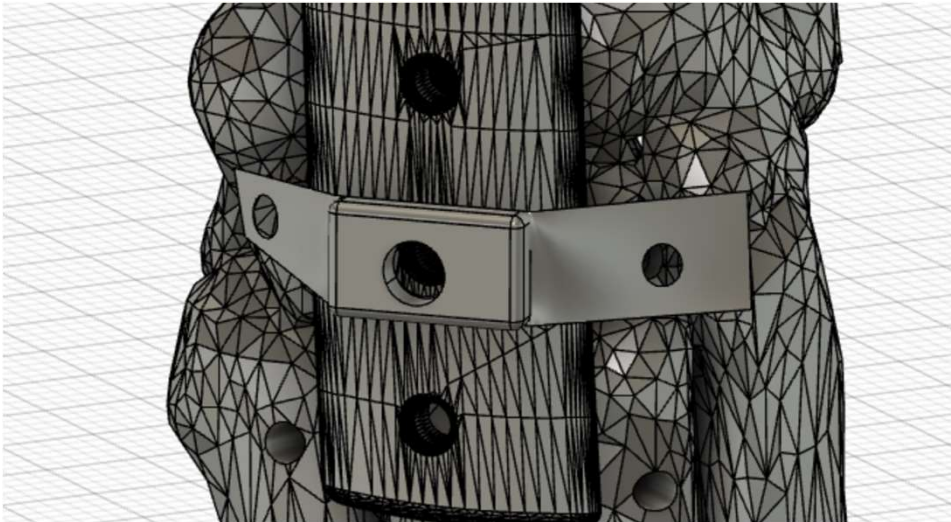
My Project

Design an additional prosthetic to augment the current design, which shares the loads and reduces screw loosening.



Proposed Solution

Fastening the plate with a stiff plastic “strap” that distributes stress across two other metacarpals.



Pros:

- Minimal impact on patient
- Does not introduce new complications
- Distributes stress across two additional metacarpals

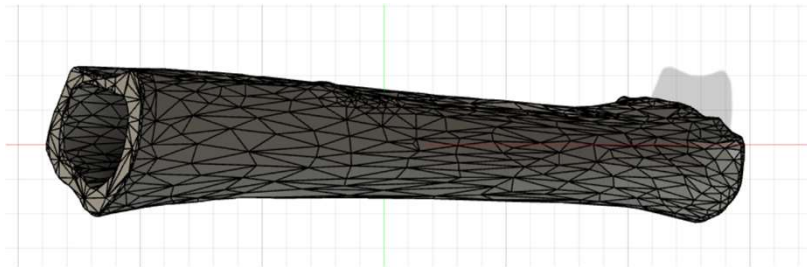
Cons:

- Involves drilling two more screws that must be removed later (one goal is all hardware must be removed after healing)



Next Steps

- Device modifications will be 3D printed and tested
 - Surgical procedure developed on canine cadaver limbs
 - Mechanical testing on cadaver limbs
- Clinical trials with client dogs after testing



Conclusions

- A device was designed to mitigate screw loosening
- A surgical procedure will be developed
- Clinical trials will be enabled later this year



What benefits did you get from you SURE experience?

- During this semester I had the opportunity to...
 - Sharpen my CAD skills
 - Learn how to slice STL files into G-code
 - Print my designs on a standard PRUSA printer and a Hyrel Hydra.
- However, the most important lesson I learned was that proper preparation and forethought are central to any goal one wishes to achieve.

References & Acknowledgements

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All CAD models were made with Autodesk Fusion 360.



Thank you



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