Improved Orthopedic Drill System

Nick Muro, David Bates, Olivia Bresett, Laura Wind

Biomedical Engineering Capstone Design

Background

- There are approximately 22 million orthopedic procedures worldwide each year.
- Orthopedic drilling during surgery requires a high level of experience and expertise to minimize complications involving thermal osteonecrosis and plunging through the bone.
- Thermal osteonecrosis refers to the death of bone caused by excessively high temperatures in the surrounding tissue.
- Bone plunging occurs when a drill bit reaches too deep into the patient and surpasses the sight of implantation, affecting other tissue.
- An improved orthopedic drill system that allows for the close monitoring of temperature and drilling depth as well as an internal cooling system would mitigate the risks of operations and increase the probability of properly functioning implants.

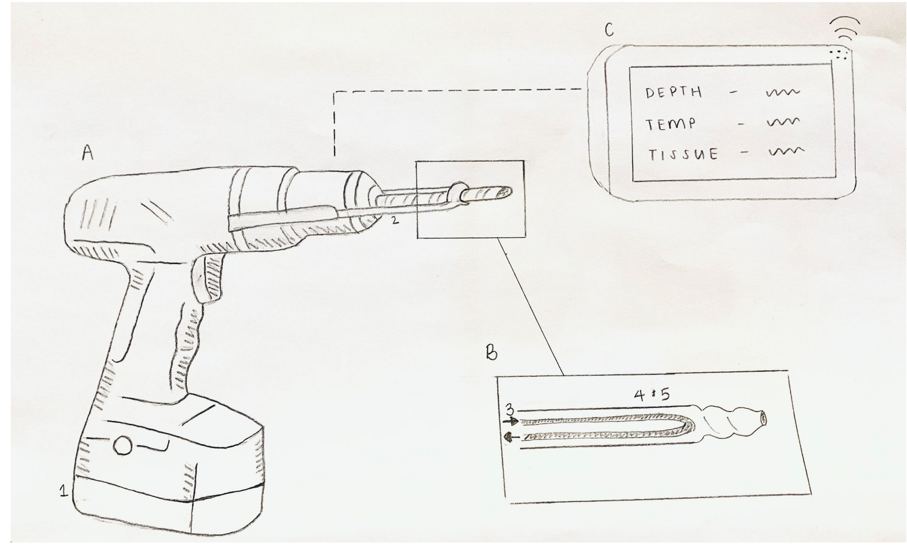
Design Objectives & Functions

- Create an orthopedic drill that reduces the temperature of the drill bit to prevent thermal osteonecrosis
- Develop a system that provides bone depth feedback to the surgeon to help prevent bone plunging.

A Orthopedic Drill
- **1** Coolant Reservoir
- **2** Preventative Depth System

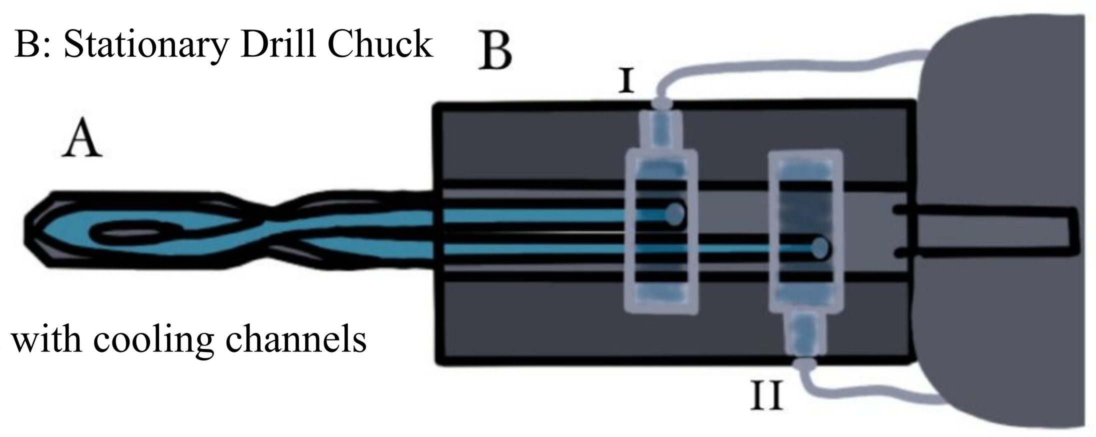
B Drill Bit
- **3** Coolant Channel
- **4** Temperature Sensor
- **5** Soft Tissue Sensor

C Monitor



Internal Cooling System

- A drill bit with an internal cooling channel was designed to allow a coolant to be pumped through.
- A tub transports the coolant to a hollow chamber which feeds the internal channel through a hole in the bit.
- The coolant then travels through the entirety of the bit before exiting into another hollow chamber and back into the coolant reservoir.



I: Inflow channel with hollow chamber connecting to inflow channel in bit

B: Stationary Drill Chuck

A: Drill Bit with cooling channels

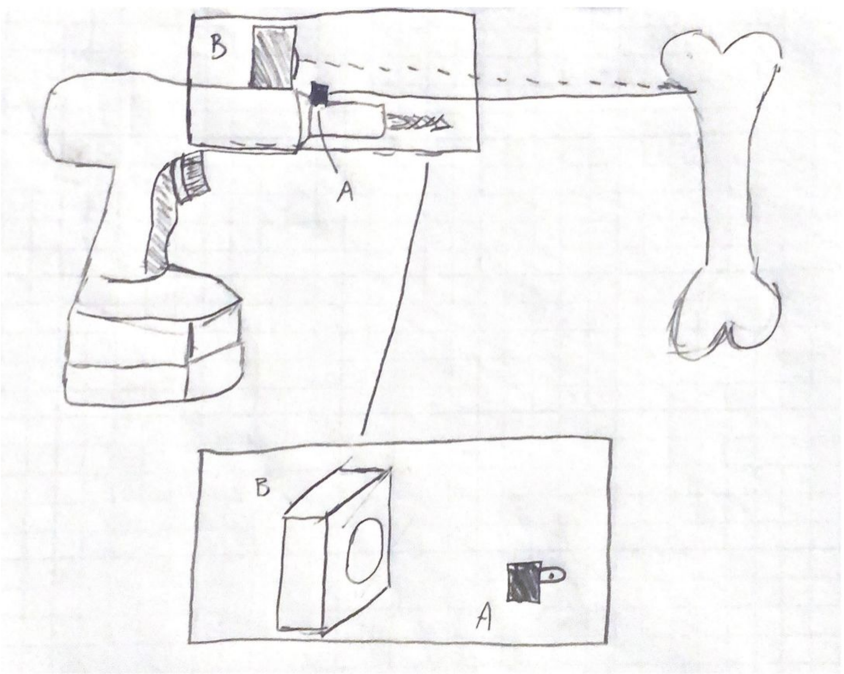
II: Outflow channel with hollow chamber connecting to outflow channel in bit

Depth Sensor

- A laser range finding sensor was used to calculate depth and was designed to fit ergonomically on top of the drill.
- As the drill bit moves down into the tissue, the laser would become closer to the sensor and the distance would be displayed on an LCD screen.

A: Laser pointing directly onto bone being drilled into.

B: Laser range finding sensor that calculates displacement.



Results

- Our design to incorporate an internal cooling system with reservoirs was promising but still held many difficulties.
- Being able to maintain constant fluid flow through a drill bit without the twisting of tubes remains a challenge.
- We have been researching other potential methods for cooling the drill bit, one of which includes an external spraying system.
- A laser based depth sensor would be ideal as it could be placed on top of the drill and avoids any interference with the surgical site.
- The main issue with this system is that the laser may not reflect off the surgical site enough to provide accurate measurement. Accurate laser range finding sensors are also expensive and difficult to obtain.
- As we continue designing the depth sensor we will consider a mechanical system instead that pushes up against the skin as the drill proceeds further into the bone.

Discussion & Conclusions

- In the future, an orthopedic drill with a fully functioning cooling system and depth sensor could drastically benefit surgical procedures, for both the surgeon and the patient.
- We plan to continue research on the orthopedic drill and its respective subsystems as we believe further prototypes and new designs could help this come to fruition.

Acknowledgements

- Union College Sternlight Bioengineering Fund
- Professor Cotter, Professor Loya, Professor Currey
- Dr, Michael Mulligan