The Development of Next-Generation Ultrasonic and Vibration Assisted Surgical Tools for Bone Cutting (VIBONE)

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Abstract
Bone cutting is one of the oldest procedures in surgical medicine. However the design of saws and drills has not advanced significantly in recent decades. Non-conventional processes are being developed to overcome the shortcomings of today’s tools. One such process is ultrasonic/vibration assisted bone cutting. Reported benefits include reduced reaction forces, and less collateral damage and fiber tearing.

Conventional Bone Cutting Tools

![Examples of conventional bone cutting tools](image1.png)

Shortcomings include:
- Reduced Control
- High Cutting Force
- Elevated Temperatures
- Soft Tissue Damage due to snagging

Bone Structure

![Bone structure](image2.png)

Components of an Ultrasonic Bone Cutting System & Challenges

![Current Ultrasonic Cutting Device](image3.png)

- Amplifier and Control System
- Ultrasonic Transducer
- Horn and Vibrating Cutting Tip

![Thermal Necrosis of Bone](image4.png)

![Undesirable Vibrations](image5.png)

![Low Material Removal Rate](image6.png)

Project Objectives

**Variables**
- Frequency
- Amplitude
- Force
- Cutting tip Design

**Effects**
- Chip Formation
- Soft Tissue
- Micro Fractures
- Thermal
- Bone Cells

**Outcomes**
- Understand the fundamental mechanism of material removal for ultrasonic tools
- Design a tool that utilises the optimum parameters for the cutting of bone

References: