Cavitation-Enhanced Fragmentation of Tissue using Ultrasonic Surgical Aspirating Horns *Brian Roach & Derek Cao*

ABSTRACT

Ultrasonic Surgical Aspirators are well known for precision in cutting soft tissues such as brain tumors and liver; however the system's efficiency in cutting hard tissues such as bone and efficacy in fragmenting tenacious viscoelastic and fibrous tissue could be improved to enable expanded applications. Cavitation might be exploited to improve efficacy by utilizing the energetic collapse of bubbles to assist in fragmenting tissue. Visual validation experiments confirmed that the system has different cavitation thresholds with 23 kHz and 36 kHz driving frequencies in both distilled water and saline. The frequency spectra obtained during these experiments using 500 kHz and 1 MHz ultrasonic transducers verified the presence of a cavitation signature (broadband noise). Similar cavitation signatures were observed when the same detection technique was applied in fresh bovine liver and beef steak, suggesting the occurrence of cavitation in tissue. In addition, removal rate studies have shown up to a 60% increase in tissue removal using cavitation-assisted cutting methods. These results have facilitated a method to monitor cavitation in tissue. Moreover, these results also show the feasibility and practicality of implementing mechanisms to enhance tissue fragmentation using cavitation-assisted cutting methods, with the potential to improve the outcome of future surgeries and the capability of enabling new medical applications.