INTRODUCTION

The costal cartilage connects the anterior portion of the ribs to the sternum and is commonly fractured due to blunt thoracic loading [1]. However, few studies have quantified the biomechanical properties of costal cartilage, which consists of an interstitial matrix surrounded by the perichondrium (Figure 1). The perichondrium contains an inner chondrogenic layer and an outer fibrous layer, and has been shown to provide a substantial contribution to the stiffness of the costal cartilage [2,3]. While some previous research has focused on the tensile material properties of the interstitial matrix [4], there are no studies that have focused on the tensile properties of isolated perichondium samples. Therefore, this study aims to quantify the effects of loading rate and age on the tensile material properties of human costal cartilage perichondium.

METHODS - SAMPLE FABRICATION

To date, fifty-three (n=53) two-layered perichondrium samples (i.e., chondrogenic and fiber layers) have been tested from twenty-five (n=25, 8 female, 17 male) donors ranging from 11 to 69 years of age (Avg. 45±16). The majority of the samples were made using the remaining tissue from the previous interstitial matrix tension testing study (Figure 2) [4]. Eight (n=8) additional non-fiber samples were made from five (n=5) donors ranging from 11 to 67 years of age. All tissue was ethically obtained through the Body Donor Program at The Ohio State University and Lifeline of Ohio.

RESULTS

Since the study is still ongoing, the data plotted should be considered preliminary. The stress-strain curves for the slow loading rate show that the ultimate stress and stiffness decreased when moving from the outer perimeter (i.e., two-layered perichondrium samples) to the mid-substance (i.e., interstitial matrix samples) (Figure 9). The data also show that the ultimate stress and stiffness of the two-layered perichondrium samples decreased with advancing age (Figures 10-11). Neither ultimate stress nor strain differed considerably with loading rate, based on the averages from matched tests at both rates for fifteen (n=15) subjects (Figure 12).

DISCUSSION & CONCLUSIONS

The preliminary data from this study indicate that age and sample type have a considerable effect on the tensile material properties of the perichondrium. Further testing is currently being conducted to obtain additional perichondrium tests for each loading rate. Upon completion of the testing, video tracking will be used to obtain more precise strain data. Statistical analysis will then be performed to evaluate the effect of age, loading rate, and sample type on the material properties.

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REFERENCES