INTRODUCTION
In order to understand diseases such as osteoarthritis and the biomechanical factors which stimulate regenerative processes, a more complete knowledge of cellular biomechanics must be realized. The first steps toward this goal have been made with our development of an integrated micro-particle image velocimetry and optical tweezer (µPIVOT) system for chondrocyte and osteoblast biomechanics. The integrated device quantifies multiaxial biomechanical properties from a single living cell. In order to enhance the capabilities of the µPIVOT, a microfluidic chip was designed and fabricated for control of the local microenvironment. The microfluidic chip is a testbed tailored to facilitate mechanical test sequences including the shear and extensional manipulation of individual biological cells.

METHODS
Mechanical stresses will be applied either through direct laser manipulation from the dual OT or through fluid induced stresses from external flow fields. An apparent limiting factor in induced hydrodynamics stresses is the potential for overheating the cell due to an increase in laser power associated with trapping. A solution is to trap the cell at stagnation points within the flow (Figure 1) [1,2]. The cell experiences zero net force at a stagnation point/plane regardless of the magnitude of the shear or extension rate. In practice, the OT will be present to apply small restoring forces since the stagnation point represents a saddle point, unstable to perturbations in particle position. The first design iteration of our microfluidic chip included cross-junction channel geometry to create a stagnation point.

Utilizing the OT and translation of the microscope stage, an individual cell may be retrieved from a culture reservoir and positioned in one of two testing regions (Figure 2). This procedure can be repeated to perform sequential measurements of cells in nearly identical conditions for statistical comparison of larger sample sizes.

REFERENCES

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