Alternative Design 3
3-Point Bending Device to Measure Transmural Strains for Multilayer Soft Tissue Composite

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This alternative design is similar to the previously described designs because of the use of the computer controlled stepper motors, calibrated bending bars, a high resolution camera, using a water bath, LabVIEW as well as MATLAB calculations. Differences in this design vary mostly in utilizing multiple bending bars as well as making the camera immobile and allowing the movement to be confined to zooming only.

This design will use four bending bars in combination with strain gauges to calculate the deflection as well as the force applied. One difficult aspect is attaching the strain gauges. The strain gauges available to use are too big to place on the thin acupuncture-like needles, however the force applied from these needles or bars are in question. Using these very thin, flexible needles will produce the smallest possible forces which will enable us to calculate the strains produced in the very small linear region in question. To incorporate strain gauges into this design, they would have to be fixed to something larger than the bending bar that will also come in contact with the bending bar. Using a sleeve to hold the tissue specimen in place will also enable the strain gauges to be held at a constant position. By incorporating the strain gauges into the sleeve, specifically at the posts holding the tissue, two of the bending bars can be positioned to press against the strain gauges as the linear actuator applies the bending bars at various forces. By having two bending bars and two strain gauges, this will give us more accurate results. It will enable the program to average the two found forces from the strain gauge to get accurate and reproducible results.

The third bending bar that is mobile will physically deform the tissue being tested. This third bar will move along with the linear actuator and deform the tissue while the other two mobile bars will be calculating the force applied. The amount of deformation of the tissue will be calculated visually in reference to the final bar being used as the reference bar. This fourth bar will not move at all but will be positioned at the beginning of the experiment in a horizontal line with the other three bars. The distance between the bar bending the tissue and the reference bar along with the force calculations from bars one and two be enough for all calculations.

Another main component of this design is to keep the camera at a constant position. Keeping the camera at a constant angle and position will eliminate the programming of the linear actuator to move both the bending bars and camera simultaneously. After determining the optimal angle of the camera to be able to capture the deformation of the extremely small markers, the camera will be placed as close to the tissue sample as possible allowing room for movement of the bars. The user will hopefully have the option of being able to zoom in and out of the reference frame from controls created through LabVIEW. By having the camera set to a specific frame, this will eliminate any focusing issues to create the clearest picture possible resulting in the most accurate results.
The bath will be similar to previous designs and circulate warm water around the inner bath. All LabVIEW and MATLAB programming will be used to program and calculate all components of this design. The figures shown below depict the various positions of this design.

Figure 3.1 Top View Alternative Design 3

Figure 3.2 Side View Alternative Design 3