Measuring Forces with an In Vitro Culture Stretcher

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Purpose

With the advent of tissue engineering, the importance of proper mechanical stimulation of cultures has been recognized. **Our device combines adjustable tissue mechanical stimulation while also measuring cellular response forces to help researchers advance their work.**

Background

- Tissues need mechanical stimulation for growth and proliferation.
- Non-optimal stimulation causes tissue atrophy or damage.
- Cells respond to stimulation with their own contractile forces, which correlate to the amount of extracellular matrix excreted.
- Our design modifies a previous device that performed only bi-axial strain of equal magnitude.

Device Blueprints

Design Criteria:

❖ Portability
- Weight < 20 lbs.
- Detachable extension for measuring cellular response forces.
- Fits in incubator.

❖ Rapid attachment to extension.

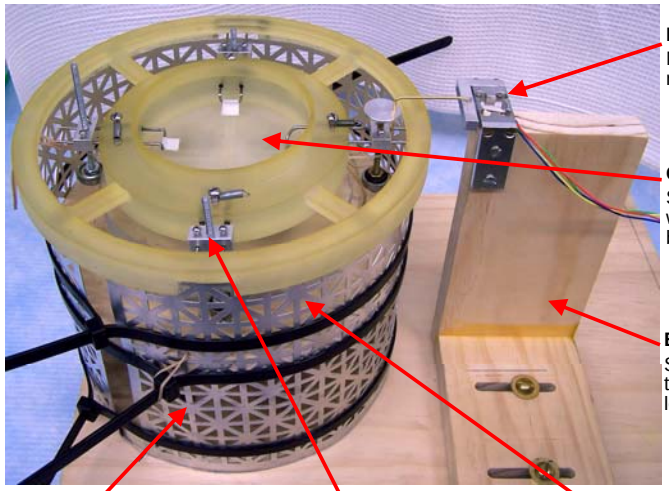
Improvements over Current Device:

❖ Dual cam system
- Independent magnitude of strain for each axis.
- Variable strain frequency between axes.

❖ Measurement of cellular response forces of seeded gel.

❖ Low RPM motor provides lower strain frequency.

Device Components



Load Cell. Measures cell response forces.

Cell Culture. Substrate seeded with cells stretched by arms.

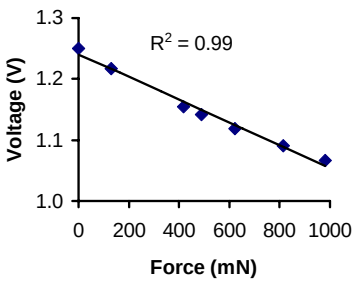
Extension. Support system that houses the load cell.

Motor. Low RPM, high torque. Powers cam.

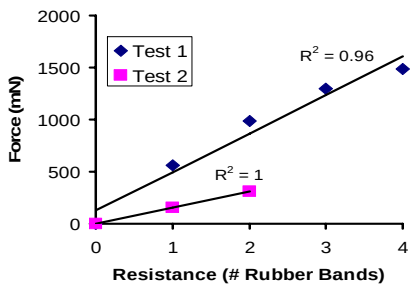
Arms. Stretches gel in center of lid.

Dual Cams. Rotates with varying curvature. Drives arms.

Calibration and Load Testing



Calibration Curve. Calibration resulted in standard curve. Load cell test yielded a consistent linear relationship between force and voltage.



Mechanical Load Test. Forces on load cell increase linearly with the resistance. Two curves reflect different magnitudes of strain.

Longevity Test. Device sustains a 10 RPM speed for 48 hours without halting, slipping, or losing speed.

Testing Protocols

Calibration:

❖ Standard curve constructed by correlating known weights to output voltage.

Mechanical Load Test:

❖ Rubber bands replace cell culture for contractile force.

❖ Multiple rubber bands correlate to higher measured force.

Longevity Test:

❖ Device remained powered for 48 hours, correlated to actual device operating conditions.

Discussion

❖ Our multi-axial strain and force measurement device provides:
- Accurate force measurement from 0.1 to 1.5 N with current load cell.
- Consistent stretching over the standard operating periods.
- Easy transition between cell stretching and force measurement functions.
- Adjustable strain application by switching cams.

❖ Future devices may incorporate:
- Different scaffolding material.
- Simultaneous cell stretching and force measurement.

References

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2. Eastwood M, McGrouther DA, Brown RA. *Biochim Biophys Acta* 1994;1201(2):186-92.

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