MEASURING the TOUGHNESS of SOLID CANCERS
A FRACTURE MECHANICS APPROACH

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Tissue Stiffness Drives Tumor Formation

PANEL 1: Cells of a normal breast duct

PANEL 2: Structure of the duct begins to degrade

PANEL 3: Uncontrolled cell growth of duct-lining cells invade the duct tube

Tensional homeostasis and the malignant phenotype

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Elastography
- Manual Compression
- Transient Elastography
- Acoustic Radiation Force

Stiffness

Stiffness Measurement

- Height change at force change is determined by the stiffness
- Interaction function: elastic constants

Fracture Mechanics Based Method

Elasticity + Fracture Creation

Fracture Toughness

Courtesy: O.Marti
FRACTURE MECHANICS
Describes how cracks initiate & propagate in solids and semisolids

FRACTURE Leads:
- Two new surfaces
- Energy is consumed to overcome Surface Energy

FRACTURE TOUGHNESS >>> REPRESENTS
Energy needed to create a unit fracture surface

Mode 1 Fracture

Courtesy: Prof. Ramesh [IIT Madras]
This movie clip demonstrates the technique of manual probing of the solid thyroid tumor with a fine needle. Note the apparent ease with which the needle travels through a non-cancerous tumor. In contrast, a cancerous tumor offers substantial resistance to needle insertion and penetration. Remarkable differences in haptic force cues were apparent between cancerous and benign tumors.

Click here for file [http://www.biomedcentral.com/content/supplementary/1754-1611-2-12-S1.mov]
Simulations: Haptic Differences Between Benign and Malignant Tumors

**Benign Tumor:**
No Resistance to Needle Penetration

**Malignant Tumor:**
Variable Resistance to Needle Penetration
In vivo analysis of fracture toughness of thyroid gland tumors

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PROTOTYPE:

Mechanical Device to measure fracture toughness of solid tumors is under development.
Summary

Fracture Toughness
Mechanical Property of Solid Tumors
Potentially Quantifiable
Mechanical Tumor Marker

Goal – Next Phase
Measure fracture toughness of a solid tumor
Assess malignant potential

The End