Quantitative Diagnosis of ACL Rupture in Canines

Team Members: Alex Bloomquist, Graham Bousley, James Madsen, Mike Nonte

Advisor: Prof. Wan-Ju Li
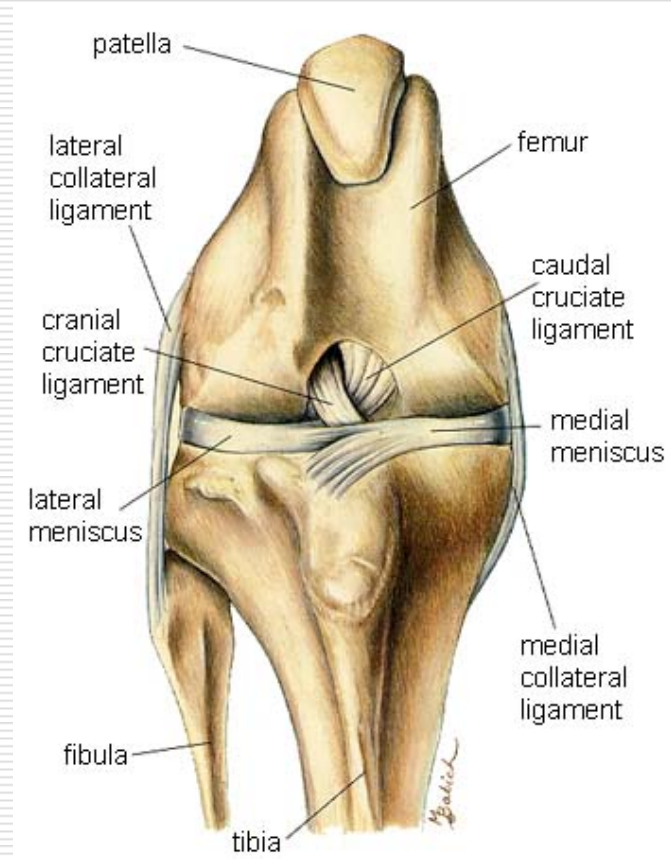
Client: Dr. Peter Muir

Overview

- ☐ Background
- ☐ Problems with current method
- ☐ Previous Work
- ☐ Design Requirements
- ☐ Design Goals
- ☐ Force and Displacement Measurements
- ☐ Improvements
- ☐ Data
- ☐ Future Work

ACL Rupture

- ACL prevents anterior-posterior tibial translation
- Rupture under natural activity
- Synovial fluid inside knee joint becomes inflamed causing rupture
- In 2003 owners spent $1.32 billion for the treatment in United States
- More than 1.2 million cruciate-ligament repair each year in U.S.

patella

femur

lateral collateral ligament

caudal cruciate ligament

cranial cruciate ligament

medial meniscus

lateral meniscus

medial collateral ligament

fibula

tibia

Source:http://www.dog-health-handbook.com/image-files/stifle.jpg
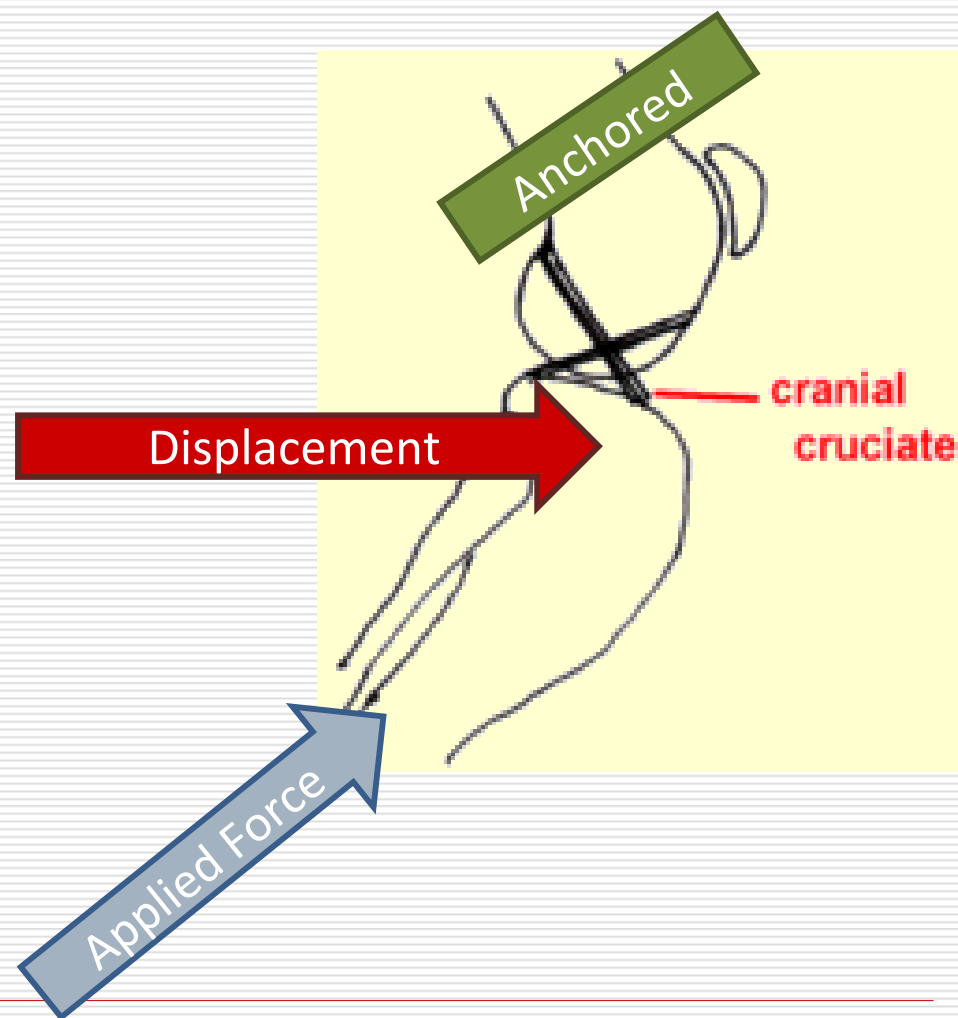
Problems With Current Diagnosis
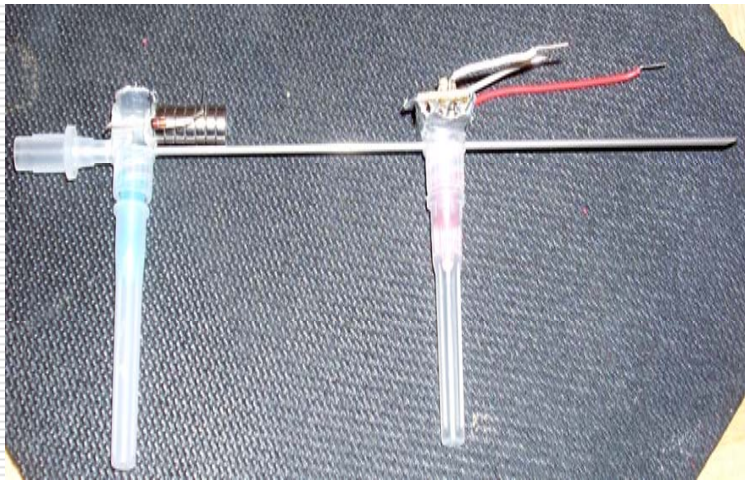
□ Cranial Tibial Thrust Test
- Does not provide a quantitative measurement of displacement or applied force
- Veterinarian must be experienced in this technique for accurate diagnosis
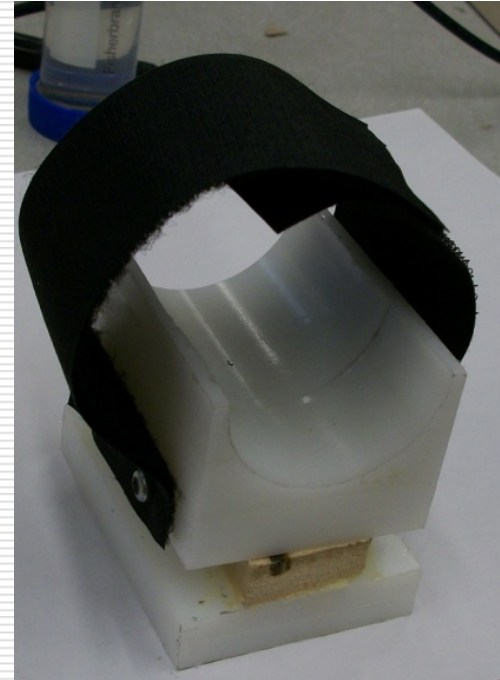
□ Stress Radiography
- Too Expensive

Anchored

Displacement

cranial cruciate

Applied Force

# Previous Work

Quantify displacement with
Hall Effect

Quantify Force
using Load Cell

Design Requirements

- Internalized system
- Sterile device
- Inexpensive
- Accurate relationship of data

Design Goals

- Quantify the relationship between tibial translation and applied force in canines with healthy or ruptured ACL ligaments

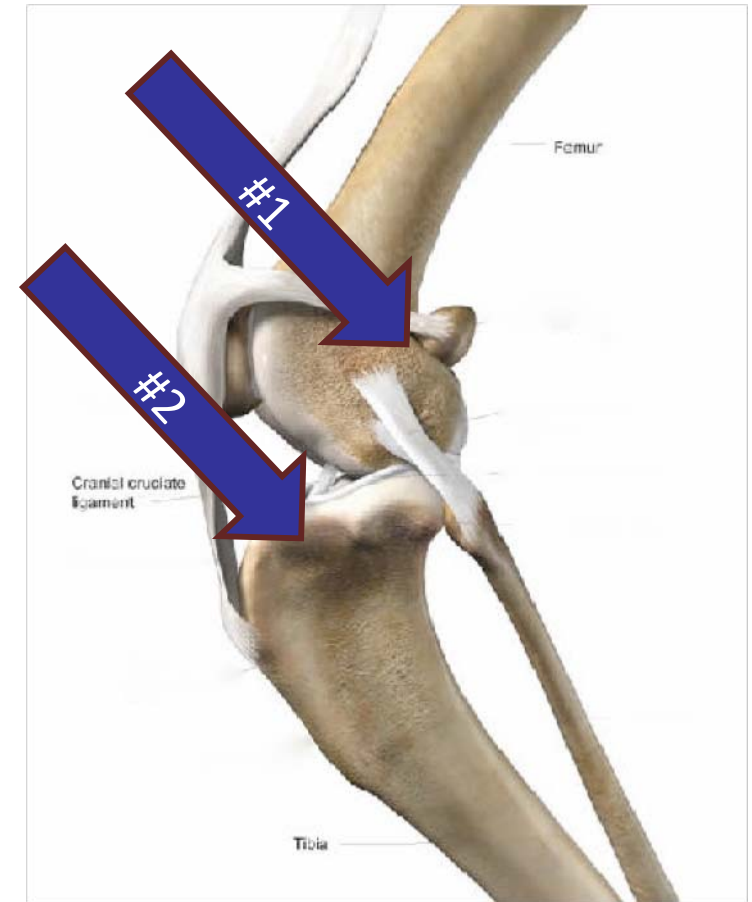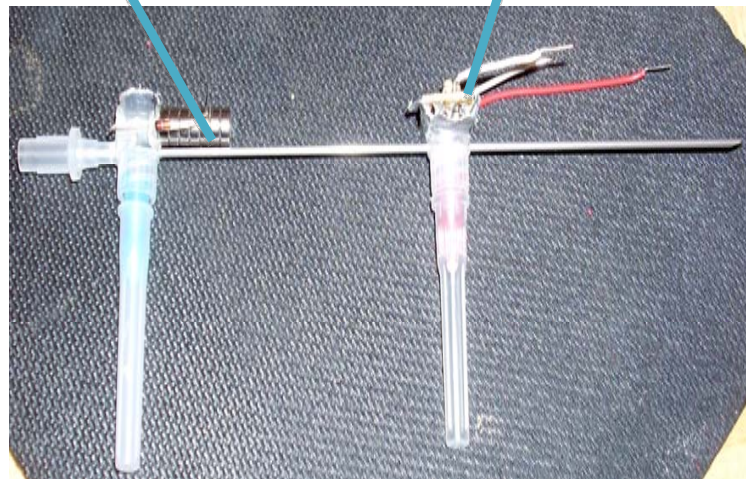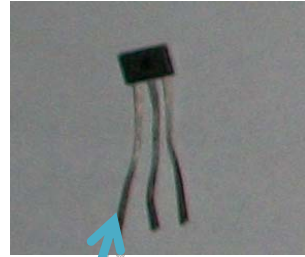- Preliminary parts have been developed and our goal is create and test a working model
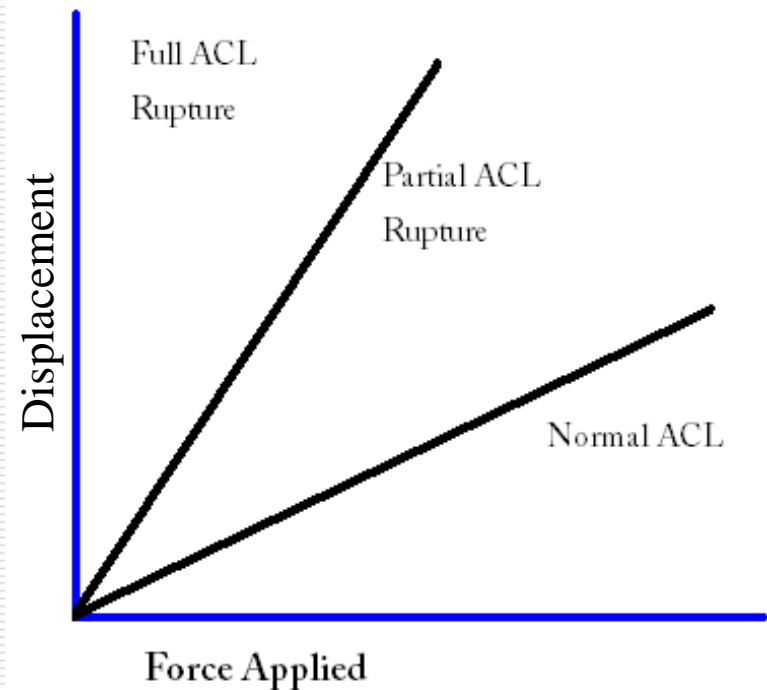
Measurement of Displacement

• One needle is fixed while the other is free to move

• As the hall effect sensor approaches the magnet, the voltage output on the sensor decreases
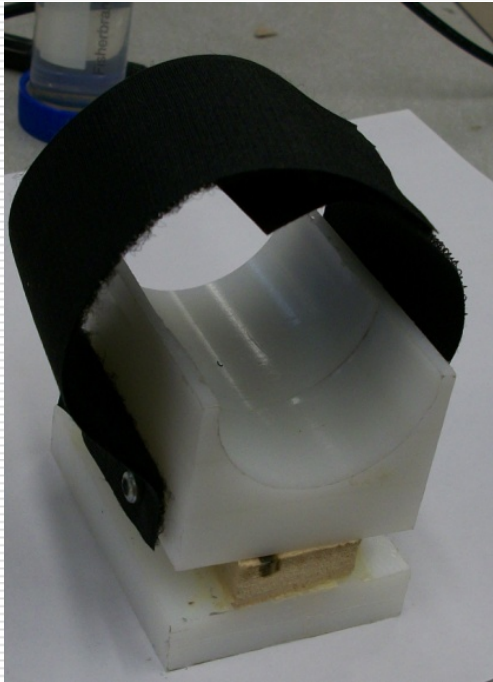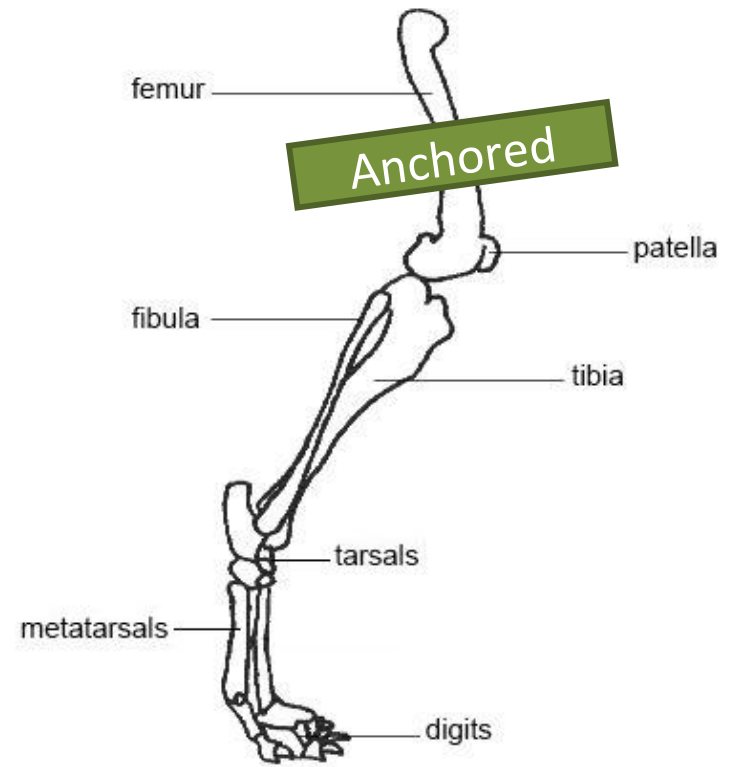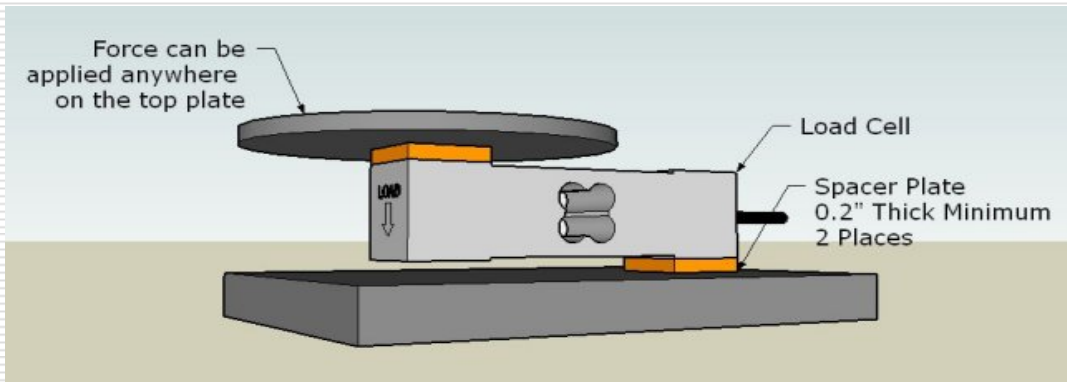
Magnet

Hall Effect Sensor

Source: http://www.warrenanimalclinic.com

• Hypodermic needles placed at specific anatomical markers
  – 1. Fabella
  – 2. Top of Tibia

Measurement of Applied Force

- [ ] A load cell is attached to the paw by a velcro strap to determine the exact force being applied to the leg
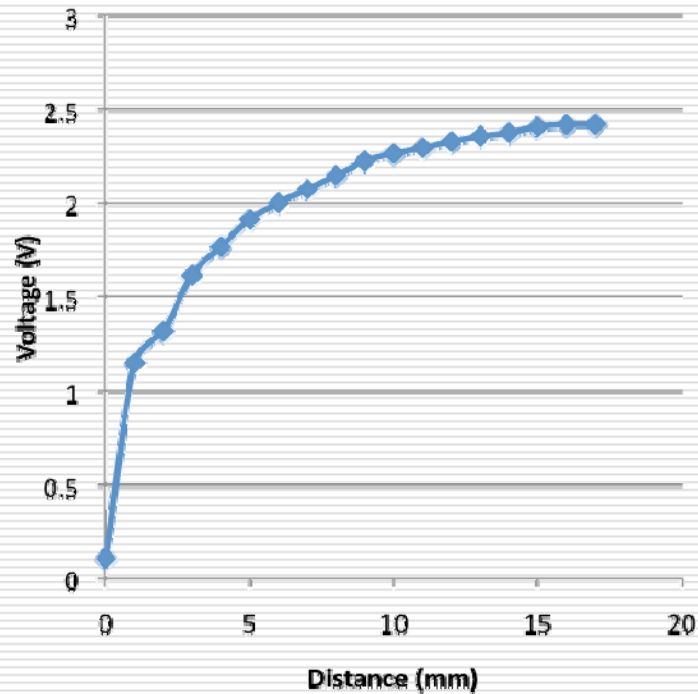

femur

Anchored

patella

fibula

tibia

tarsals

metatarsals

digits

Source: http://www.justanswers.com/

Applied Force

Force can be applied anywhere on the top plate

Load Cell

Spacer Plate 0.2" Thick Minimum 2 Places

LOAD

Improvements

- ☐ Zener diode
- ☐ Repeatable testing
- ☐ Internalized system

Preliminary Data

Hall Effect Measurements

Voltage (V) vs Distance (mm)

Load Cell Measurements

V-out (V) vs Load (kg)

$R^2 = 0.9957$
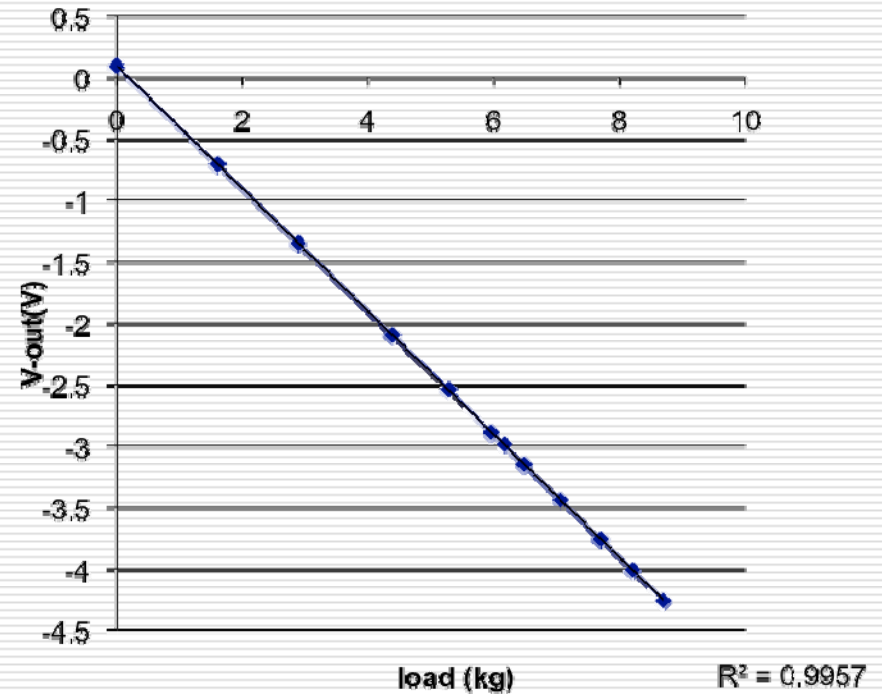
Future Work

- Testing of device on cadavers
  - Determine healthy/unhealthy ranges for applied force/displacement relationship
- Machine Final Prototype
- Explore possibility of using a similar device to diagnose ACL deterioration in humans

Acknowledgements

- Peter Muir, PhD
- Amit Nimunkar
- Wan-Ju Li, PhD
- Lacey Halfen, Grad Student
- Peter Klomberg, Grad Student