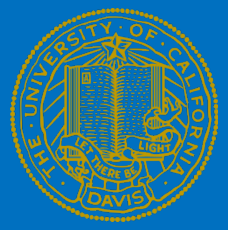
Properties of Distal Femoral Defects with a Cortical Breach

Derek F. Amanatullah, M.D., Ph.D.
Joel C. Williams, M.D.
Robert M. Tamurian, M.D.

Orthopaedic Research Laboratory
Department of Orthopaedic Surgery
University of California at Davis



Disclosure

All data and collected and analyzed without funding or sponsorship from any outside source.

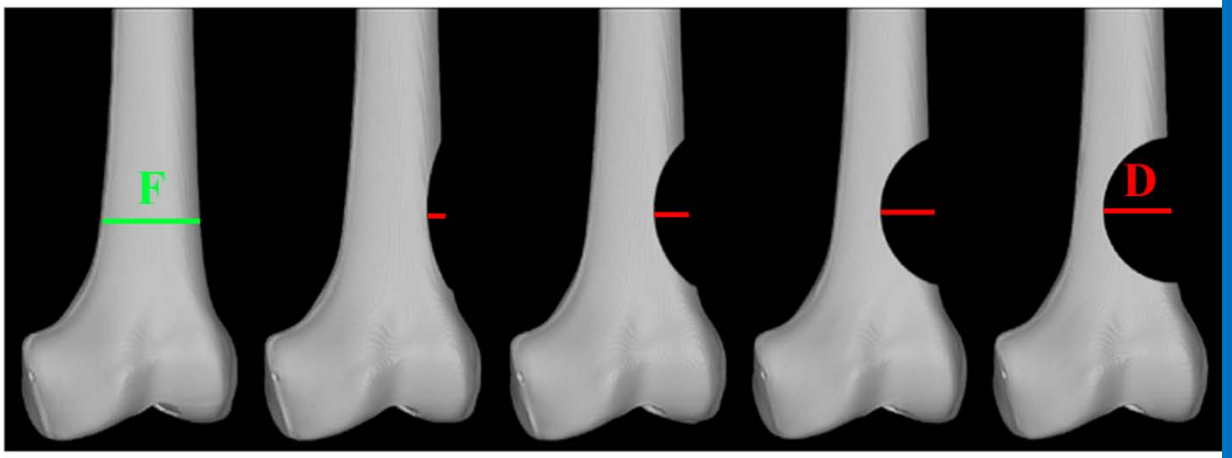
Background

- Optimal management of pathologic long bone fractures remains a significant problem. A clear set of guidelines has yet to be described, most are based on retrospective data with little biomechanical support.
- Mirels' system offers a 81-91% sensitivity but only 33-35% specificity (Damron 2003, Evans 2008). Great for screening; Poor for prediction = Unnecessary stabilization.
- Cortical destruction of more than 50% is a commonly referenced cut off for the prophylactic stabilization of long bones (Parrish 1970, Fidler 1981, Leggon 1988, Edgerton 1990, van der Linden 2004).

Hypothesis

The goal of the current study is to investigate the role of defect depth and percent of bone loss in the setting of cortical destruction on the mechanical properties of the distal femur

Lateral Distal Femoral Defects



	Intact	1/6	1/3	1/2	2/3
Removed (%)	0	16.67	33.33	50.00	66.67
Depth of Penetration (cm)	0	0.70	1.40	2.10	2.80
Radius of Defect (mm)	N/A	135.5	78.2	63.8	60.1
Height of Defect (mm)	N/A	30.0	30.0	30.0	30.0

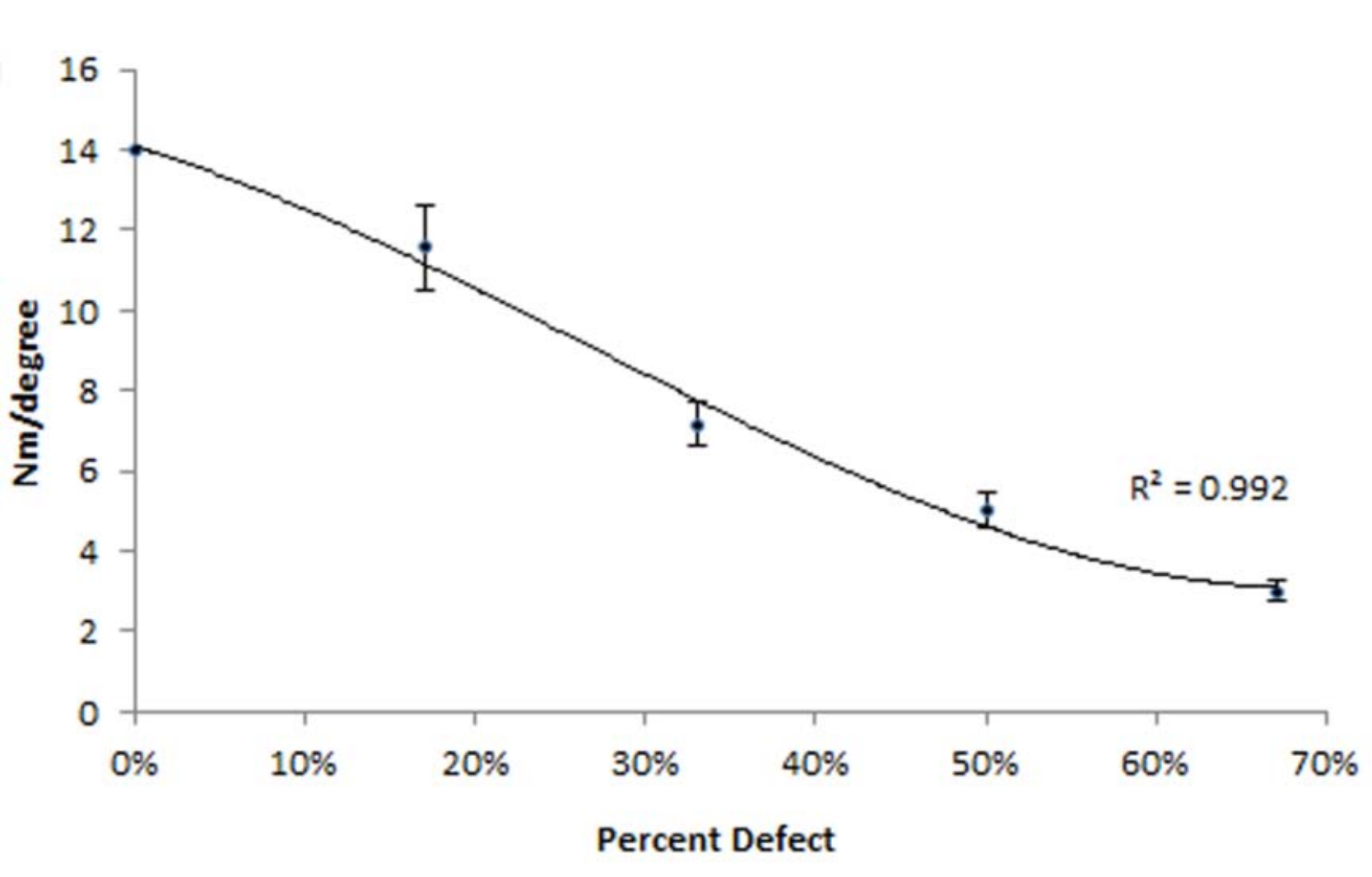
Methods

The femurs were mounted into a hydraulic axial/torsion servohydraulic materials testing machine.

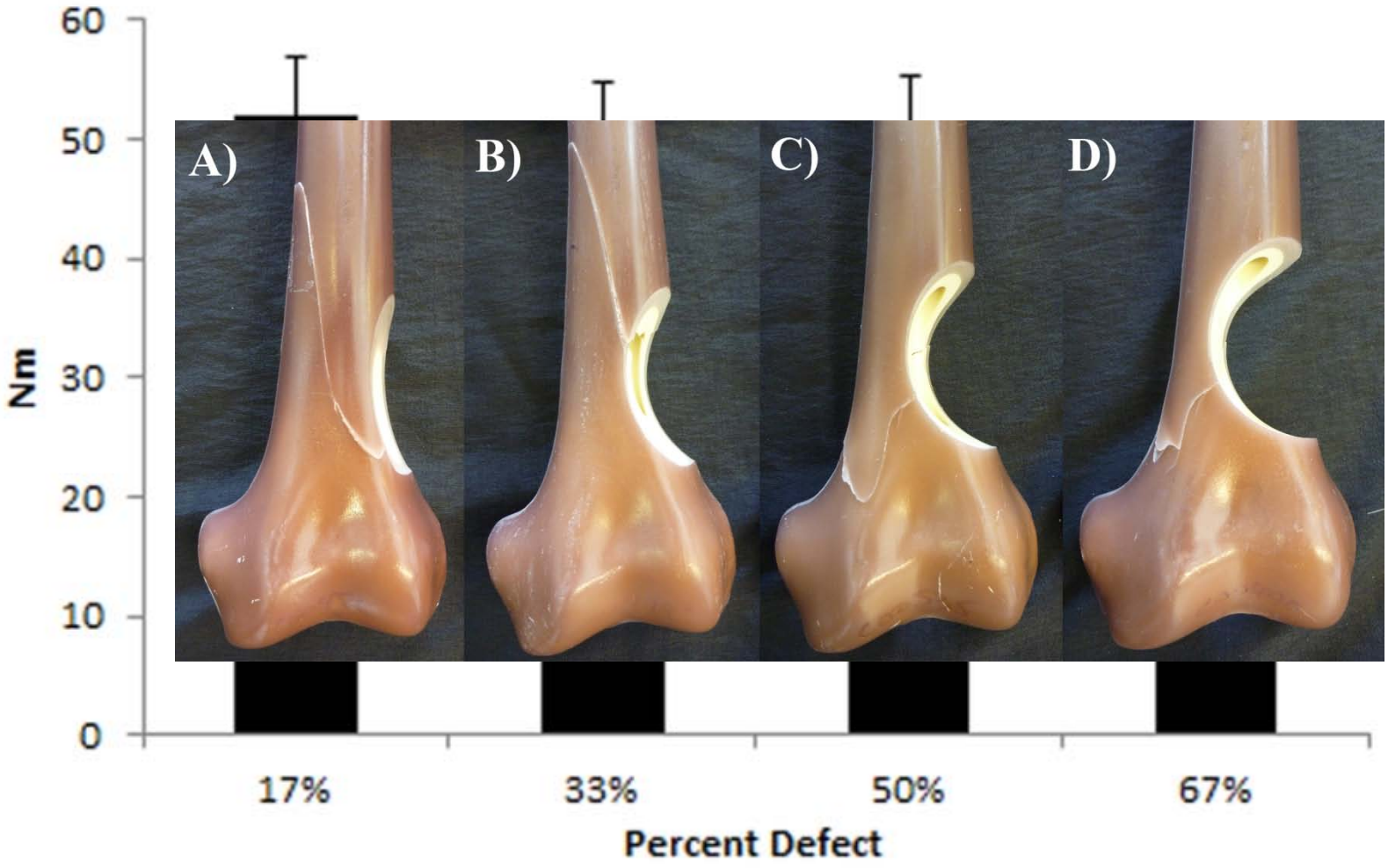
Torsional stiffness testing was then performed by loading each specimen from 0.5 Nm to 12 Nm for 3 cycles at 1 Nm/s with axial preload held at 200 N. Finally, each sample was failed in torsion a rate of 1 Nm/s with axial preload held at 200 N. Failure was defined as composite bone fracture.

Torsional stiffness were calculated from the linear portion of the torque-angle curve. Data were analyzed via a student's t-test with a Tukey-Kramer adjustment for multiple comparisons. A power analysis revealed that a sample size of 5 would offer the ability to detect a difference of 1 ± 0.5 Nm/degree between samples with 95% confidence and a statistical power greater than 80%.

Stiffness v. Defect Size



Torque v. Defect Size



Conclusions

- We predict a critical loss of bone integrity when a defect approaches 50% femoral loss with cortical destruction.
- The 50% defect had a stiffness of 5.00 ± 0.43 Nm/degree, which was 64.2% lower than the intact femur.
- The fracture pattern switched from oblique to transverse at 50% cortical loss.
- We found a significant decrease in torque to failure only after 50% cortical loss.
- We recommend a re-evaluation of the available clinical criteria for the prophylactic stabilization of distal femoral defects to include the 50% rule in the context of cortical destruction.