# IMPLANT SIZE AND MECHANICAL PROPERTIES INFLUENCE THE FAILURE OF THE ADHESIVE BOND BETWEEN CARTILAGE IMPLANTS AND NATIVE TISSUE

**Ali Vahdati, Diane R. Wagner**
*Bioengineering Graduate Program, Aerospace and Mechanical Engineering Department*
*University of Notre Dame, Notre Dame, Indiana, USA*

## Introduction

Adhesives such as fibrin are frequently used to join implanted cartilage replacements (ICRs) to native cartilage to stabilize the implant in the defect area and improve its integration to the host tissue. While the geometry and mechanical properties of ICR are expected to affect the loads and deformations [Vahdati. 2012] at the implant/cartilage interface, little is known about the relationship between these implant characteristics and the quality of the fixation. The objective of this study was to evaluate the effect of implant size, thickness, modulus (E), surface coefficient of friction (μ) and Poisson's ratio (ν) on the failure of a fibrin adhesive interface.

## Methods

Damage and failure of fibrin at the implant/cartilage interface were represented by a cohesive zone model in an idealized finite element model of the medial compartment of the human knee (Fig. 1), with both axial compression and sliding loading conditions [Vahdati. 2012]. The size, thickness, E, μ and ν of the implant were varied, and subsequently the damage at the interface between the ICR and native AC was evaluated.

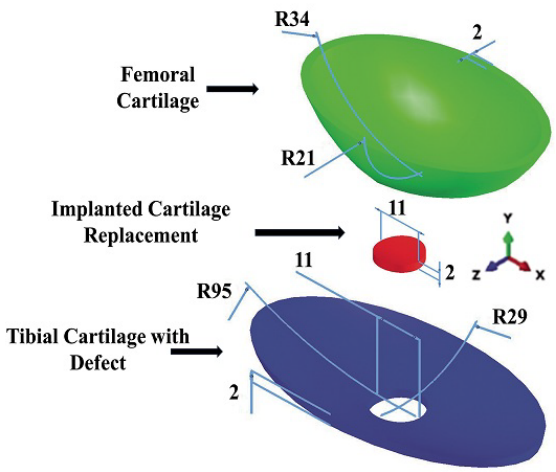


*Fig 1: Idealized model of the medial compartment of the knee joint with a full-thickness circular defect and ICR. Dimensions are in mm.*

Cohesive zone coefficients for fibrin were determined with an inverse iterative finite element technique [Vahdati 2012] using published experimental data [Silverman. 2000].

## Results

The results showed that lack of anchorage to underlying bone, larger implant size (Fig. 2), higher surface coefficient of friction and higher compliance of the implant can increase the chance of implant loosening and delamination. The Poisson's ratio affected fibrin failure in a different manner for chondral and osteochondral implants (not shown).

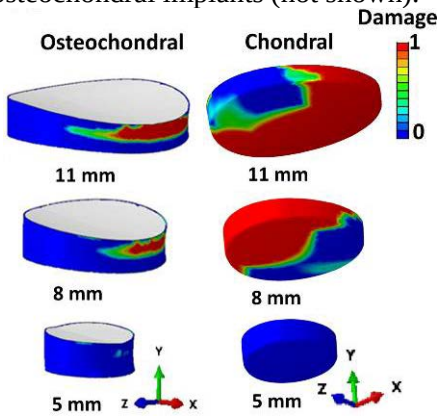


*Fig 2: Adhesive damage on ICRs of different size and type at the end of loading. Note that different views have been used to best display the damage.*

## Discussion

This study is the first computational investigation of the effect of different ICR properties on the failure of the adhesive material in knee joint chondral defects. Results showing that the geometric and mechanical properties of ICRs could significantly affect the success of the implants may guide implant design and cartilage repair techniques.

## References

Silverman *et al*, Plast Recons Surg, 105:1393-1398, 2000.

Vahdati *et al*, J Biomech Eng, 134:110004-1, 2012.

Vahdati *et al*, Comp Meth Biomech Biomed Eng, 15:1211-1221.