Letter to the Editor commenting on "Hydrostatic Pressurization and Depletion of Trapped Lubricant Pool During Creep and Sliding Contact of a Rippled Indenter Against a Biphasic Articular Cartilage Layer," Michael A. Soltz, Ines M. Basol, Gerard A. Ateshian. 2003, J. Biomech. Eng., Vol 125, pp. 585–593

Stoltz et al. addresses the over-four-decade controversy in synovial joint tribology as to what happens as two cartilage surfaces approach contact [1]. Is the fluid in the interarticular space forced into the cartilage layers in ''boosted'' lubrication ala Dowson et al. [2] or is it expressed from the cartilage layers in ''weeping'' lubrication ala McCutchen [3]?

The Soltz et al. study, which supports the Dowson ''boosted'' hypothesis is totally theoretical, as is the Dowson hypothesis with no experimental confirmation of which I am aware. In Soltz et al. a mathematically-modeled, flat, smooth, two-dimensional ''cartilage layer'' is approached and penetrated by a model of a 2-D, ''rippled, rigid indenter'' purported to represent the complex surface of natural cartilage.

The authors group their reference 2, Macirowski et al. [4] with 3 other references and characterize Macirowski et al. (along with the other 3 references) as ''a contact simulation between smooth articular layers modeled with porous media theories,'' a misrepresentation as explained in the next paragraph. More significant to this comment, the Macirowski et al. research results and conclusions in the context of synovial joint theory support the McCutchen ''weeping'' mechanism. However the Macirowski et al. conclusion supporting the ''weeping'' mechanism is not mentioned in Soltz et al.

In Macirowski et al. the inputs to the porous-media, finite-element analysis were quantitatively established by experiments on natural articular cartilage *in situ*. Using cadaver pelvi and ultrasonic techniques [5], the acetabula cartilage surface geometry, the bone-cartilage surface geometry and thereby the layer thickness and its distribution were quantified. Then using ultrasound in combination with osmotic loading [6], the cartilage permeability and modulus and their respective distributions were experimentally quantified. A pseudo femoral-head with multiple integrated pressure transducers, size matched to the acetabula, was loaded onto the cartilage and pressures and their distributions [7] verses time were recorded; for time-dependent pressure distributions see Fig. 5 in Macirowski et al. An identical pseudo femoral-head, this equipped with an ultrasonic transducer, was loaded onto the cartilage in an identical manner as the pressure instrumented device and penetration versus time recorded, see Figs. 6 and 7.

When these experimental data were incorporated iteratively into the FEM analysis, the deep cartilage interstitial pressure was found to be higher than the interarticular ''film'' pressure, see Figure 11 and the surface normal flow velocity *out of the cartilage* calculated, see Fig. 8, both consistent with the McCutchen mechanism.

Since in science, experimentally-based results trump those of theory, the Macirowski et al. support of the McCutchen ''weeping'' mechanism is more compelling than the Dowson ''boosted'' theory conclusion of Soltz et al.

References

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[4] Macirowski, T., Tepic, S., and Mann, R. W., 1994, ''Cartilage Stresses in the Human Hip Joint,'' J. Biomech. Eng., **16**, pp. 10–18.
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