**Introduction:** It is noteworthy that the friction coefficient of arthritic human or animal joints has not been reported previously. Studies of enzymatically [1] and mechanically [2] degraded bovine articular cartilage report that the friction coefficient increases with degradation. Osteoarthritis (OA) also degrades the mechanical properties of articular cartilage and it may be presumed that it would similarly increase the friction coefficient. Therefore the first aim of this study is to test the hypothesis that the friction coefficient in human tibio-femoral joints increases with advancing OA. Since current clinical treatment modalities include intra-articular injection of synovial fluid-like hyaluronan solutions, the second (corollary) hypothesis is that healthy synovial fluid (SF) significantly reduces the friction coefficient of osteoarthritic human joints compared to a phosphate-buffered saline (PBS) lubricant control. Healthy bovine SF is used as a surrogate for healthy human SF in this study.

**Materials and Methods:** SF was pooled from 10 adult bovine wrists. Fresh frozen human knees (4 males and 4 females, average age 70) obtained from a tissue bank were dissected and the menisci removed. The articular surface was stained with India ink to highlight cracks and fibrillation, and visually staged for OA (stage 1 for mild OA to stage 4 for severe OA) [3, 4]. 5 knees with stages 1 and 2 (mild fibrillation with occasional shallow fissures, Fig.1A) were categorized as mild OA, and the remaining 3, with stage 3 (deep fissures and cracks, extensive fibrillation, no exposed bone, Fig. 1B), were categorized as advanced OA.

Knees were separated into medial and lateral tibio-femoral pairs, each tested separately (2 specimens per knee, total of n=16 specimens). Two friction tests were performed on each specimen [5], starting with a physiological configuration (condyle sliding against tibia) where the contact area migrates over the articular surface (MCA test, 6.3 N load, continuous motion, ±10 mm displacement at 1 mm/s, for 900 s). In the second test, a cylindrical cartilage plug (4 mm diam., 2.1 mm thick) was excised from the tibial plateau and its frictional response against a glass slide was measured (SCA test, 6.3 N load, ±4.5 mm displacement at 1mm/s, for 3,600 s). Each specimen was tested twice, first in PBS then, after recovery, in SF. The testing device was described previously [6]. Multi-factorial ANOVA with repeated measures and Bonferroni-corrected post-hoc tests was used to examine the effect of OA (mild versus advanced) and the effect of lubricant (SF versus PBS) on the friction coefficients measured in each testing configuration (MU MCA in MCA, MU min and MU eq in SCA).

**Results:** In all the MCA tests, after a slight initial decrease, the friction coefficient (MU MCA) remained nearly constant throughout the entire testing duration (Fig. 2). No difference was found between mild and advanced OA (p=0.13) neither in SF nor in PBS; however SF produced a lower friction coefficient than PBS (p=0.022) (Table 1). No interactive effects were observed (p=0.57). In the SCA test the friction coefficient increased monotonically from a very small value MU min to a near equilibrium value MU eq (Table 1). MU min was significantly smaller than MU eq in both lubricants (p<0.001) and MU eq was statistically smaller in SF than in PBS (p<0.001). No effect of OA degeneration was observed (p=0.076).

**Discussion:** Based on these results we must reject both hypotheses of this study. In a counter-intuitive outcome, we find that progression of osteoarthritis from mild to advanced visual stage does not increase the friction coefficient in the human tibio-femoral joint. While healthy SF produces a slightly lower friction coefficient than PBS in the physiological (MCA) testing configuration, the benefits of using healthy SF in joints with advanced OA are not apparent. Based on our earlier studies [7, 8] we interpret these findings to mean that cartilage from human joints with visual OA stages 1 to 3 maintains sufficiently functional properties to promote the interstitial fluid pressurization necessary to produce a low friction coefficient. Indeed the friction coefficients observed here are very similar to our earlier results with healthy immature bovine knee joints [8], suggesting that cartilage functional properties are remarkably resilient to OA degradation from visual stages 1 to 3. It is important to keep in perspective that visual stages of OA assessed from dissections typically overestimate radiographic stages of OA. In particular, no joints tested in this study exhibited eburnated or even exposed bone, as would be expected in advanced radiographic staging of OA. For such joints, it may still be reasonably expected that the friction coefficient would be significantly greater than in health, as will be investigated in our future studies.

**References:**

**Acknowledgements:** Study supported by the NIH (NIAMS AR43628)