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A NOVEL APPROACH TO MEASURING STRESSES ON THE KNEE CARTILAGE USING FIBER-OPTIC TECHNOLOGY

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Summary: Change in stress has been hypothesized to be a significant factor in the initiation and progression of knee osteoarthritis (OA). Without a reliable method for measuring stress this hypothesis has largely gone untested; Understanding stresses within the joint is central to understanding the etiology and progression of degenerative osteoarthritis, as well as the effects of clinical interventions meant to slow or halt OA progression. Clinical symptoms such as pain and cartilage degeneration are also widely believed to be related to changes in stress magnitude and distribution across the joint. This study is the first accurate direct measurement of in-vivo stress in a joint during gait accomplished by combining our capability to reproduce in-vivo motions accurately and improvements in fibre optic technology,

Currently the most widely used method for measuring contact stresses are Prescale Film (Fuji Photo Film Co) and I-Scan (Tekscan Inc.) These methods have substantial limitations. Both are stress-sensitive films that are inserted into the joint thus altering natural mechanics and lubrication. They require a significant amount of dissection and the removal of biomechanically relevant structures. Significant errors are also associated with their thickness, curvature, and modulus dependency resulting in large errors and unreliable data.

To address the existing knowledge gap, we have used fibre optic sensors specifically designed to be inserted into ovine knee joints to measure in-vivo stresses on the surface of the cartilage healthy and damaged joints (at 10 and 20 weeks post injury). With a diameter of 125-292 μm and sensing length of 1 mm these fibre optic sensors can be inserted into the joint space without the removal of biomechanically relevant structures; and with minimal disturbance to natural load-bearing mechanics. They are both compliant and biocompatible, allowing for more accurate measurements. These sensors address many of the limitations associated with stress sensitive films and while there are challenges associated with their use, we have successfully obtained repeatable and reliable in vivo stresses measurements. We will explain the physics and computational requirements to obtain data and our results which show a clear change in stress distribution patterns within the joint as a result of injury.