SYNTHETIC LUBRICANTS CAN INHIBIT THE DEVELOPMENT OF OSTEOARTHRITIS IN A GUINEA-PIG MODEL

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Introduction

Osteoarthritis (OA) is a degenerative condition of synovial joints involving the destruction of articular hyaline cartilage. In the 1970’s, ‘viscosupplementation’ with hyaluronan was proposed as a potential treatment for OA with the idea that it would improve joint lubrication. However, despite studies showing its ability to reduce pain, the fact that the resident time within a joint (48 hours) is much less than its clinical effect (often several months) along with pharmacological effects on chondrocytes and synoviocytes has confirmed that injected hyaluronan acts as a pharmaceutical rather than as a lubricant as originally thought [1,2]. For this reason, the effects of artificially lubricating an arthritic joint have not previously been adequately investigated. This study examines the effect of injecting an inert, synthetic lubricant on the development of OA in a surgically induced model of osteoarthritis in the adult guinea pig [3]. Our initial hypothesis was that totally synthetic, highly inert, perfluorooalkylethers (PFAE) with appropriate viscosities (3,000-30,000 centistokes) could perform optimally as mechanical joint lubricants to prevent OA. These non-immunogenic long chain polymers are based on inert fluorine polymer chemistry and contain only carbon, oxygen and fluorine in their molecule and are highly resistant to all forms of chemical interaction.

Materials & Methods

With University & Government approval, osteoarthritic changes were initiated in the right hind knee joint of 12 male Dunkin-Hartley guinea-pigs of 6 months age by excision of the medial meniscus and anterior cruciate ligament [3]. At 2 weeks after surgery, the animals were randomly assigned to 1 of 2 groups: (1) Single intra-articular injection of 1ml synthetic, sterile lubricant (PFAE16350) or (2) Control group with single intra-articular injection of 1ml 0.9% sterile saline. The animals were fed a standard SDS diet (FD-1) supplemented with vitamin C. All animals were examined and weighed weekly. At 9 weeks from surgery, after sacrifice, both hind-limbs were stripped of surrounding soft-tissue. Samples of the capsule were taken, processed, sectioned and stained with Haematoxylin, Safranin-O and Fast Green and after embedding in polymethylmethacrylate (PMMA). The sections were photographed and examined for evidence of OA. Particular note was taken as to the presence of synthetic lubricant at arthroscopy. The Tibia, femur and patella were photographed and examined for evidence of OA. After fixation in paraformaldehyde, the bones were processed and sectioned at 8 microns after embedding in polymethylmethacrylate (PMMA). The sections were stained with Weigert’s Haematoxylin, Safranin-O and Fast Green and graded for OA blindly according to a modified Mankin scoring system [4].

The results were analysed by the Mann-Whitney U test.

Results

All guinea-pigs remained healthy and moved without evidence of lameness throughout the study. The guinea-pigs joints treated with the inert synthetic lubricant PFAE16350 showed a mean modified Mankin score of 4.7 points (sd 3.5) compared with the guinea-pigs joints treated with saline where the mean modified Mankin score was 11.5 points (sd 6.2, p<0.001). In comparison, the development of spontaneous OA on the unoperated left knee joint was never greater than 2 points, in agreement with previous studies on guinea-pigs of this strain under the age of 1 year [5].

The histological/histochemical improvement in the development of OA was mirrored by our subjective macroscopic assessment in which the medial tibial plateau osteophyte was noted to be larger and the articular surface more roughened in the control cases compared to the lubricated cases.

Synthetic lubricant was noted at arthrotomy in all cases where it was injected. There was no evidence of lubricant resorption or an inflammatory response either macroscopically or microscopically.

![Graph showing difference in Mankin scores (+ standard deviation) of control versus lubricant treated guinea pigs.](image)

Discussion

The use of synthetic lubricant oils as a preventive treatment for osteoarthritis has not previously been adequately tested. This study has confirmed that synthetic, inert, perfluorooalkylether lubricants can remain in the articular space for prolonged periods and inhibit the development of osteoarthritis without initiating an inflammatory response or causing systemic toxicity. This is in agreement with our in vitro studies confirming the absence of an inflammatory or cytotoxic effect on cultured human macrophages. Synthetic lubricants such as PFAE16350 warrant further investigation for potential use in osteoarthritis.

References