MENISCUS AND ARTICULAR CARTILAGE HAVE DIFFERENT FRICTION PROPERTIES

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Introduction

Meniscus and articular cartilage tissues exhibit different extracellular matrices. Hence, it seems likely that they could also differ in friction properties. The superficial zone protein lubricin is present in the surface layers of both tissues, but it is not clear whether lubricin contributes to joint lubrication in meniscal tissue to the same extent as it does in articular cartilage. Therefore the aim of this study was to compare the friction properties and lubricin content of meniscus and articular cartilage.

Methods

10 knee joints were obtained from 6 months old calves. 6 mm plane parallel meniscus plugs were prepared out of the anterior horn of the medial menisci by use of a skin punch. Osteochondral samples of the same diameter were taken from the intercondylar eminence, where femur and tibia directly articulate with each other, and from the medial tibial plateau underneath the anterior meniscal horn. Instantaneous and equilibrium friction coefficient (μ_0, μ_{eq}) were assessed under three load levels in a pin-on-plate tribometer with a glass plate as counter surface and ovine synovial fluid as lubricant. μ_{eq} was calculated after one hour of cycling. To assess the lubricin content on the surface of the meniscus and articular cartilage additional samples were taken close to the points of harvest of the specimens used for friction testing. Surface lubricin was stained immunohistologically and the amount of positive lubricin staining quantified. For statistical analysis a paired two-sided t-test was used and the level of significance set to P=0.05.

Results

μ_0 did not differ between meniscus and cartilage samples. μ_{eq} was significantly lower for the meniscus compared to the tibial cartilage throughout all load levels (Fig. 1). Lubricin surface covering was almost 80% for the meniscus samples, thus significantly higher compared to the cartilage samples ($p<0.01$, fig. 2,3). Less lubricin was found at the tibial eminence compared to the tibial plateau ($p<0.05$).

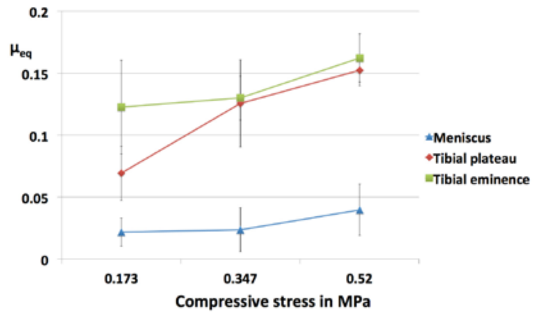

Figure 1: μ_{eq} at different load levels

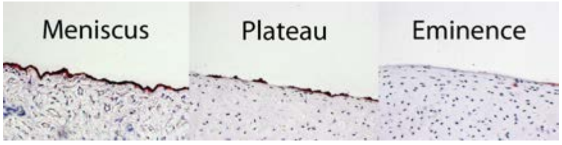

Fig. 2: Lubricin staining of the tissue surface

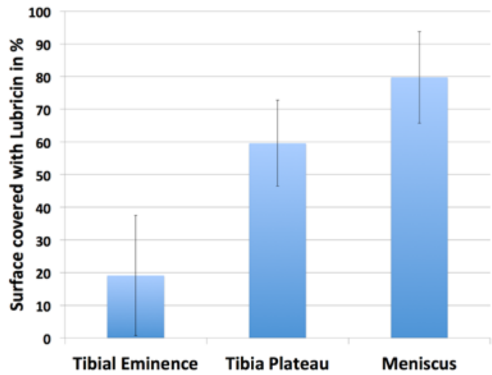

Fig. 3: Lubricin covered tissue surface

Discussion

Bovine meniscal tissue exhibited lower friction than articular cartilage, which correlated with the amount of surface lubricin, which has been attributed an important role in enabling low friction joint motion. Former studies have shown, that due to the pressurization of the interstitial fluid directly after load application the friction behaviour is dominated by the load bearing tissue fluid. Once the tissue is at equilibrium, the friction is mainly governed by the solid matrix. Hence, our results suggest, that lubricin, which is bound to the solid matrix, is more effective in reducing the friction, when the load is carried more by the solid matrix. Our study further showed that cartilage friction might also depend on the location in the joint. The different amount of lubricin found at the two cartilage locations might play a role in this finding, which requires further studies.