

# HYALURONIC ACID HAS NO TRIBOLOGICAL EFFECT ON DEGENERATED KNEE JOINT TISSUES – AN IN-VITRO STUDY

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## Motivation

Therapeutic intraarticular injection of hyaluronic acid (HA) in knee osteoarthritis (OA) intends to maintain low-friction between the articulating cartilage and meniscus surfaces by restoring the comprised viscosity of the synovial fluid (SF) [5]. However, neither the friction properties of degenerated cartilage and meniscus nor the effect of HA injections on friction between these tissues have been sufficiently studied. Therefore, the aims of this tribological in-vitro study were (1) to quantify the coefficient of friction (CoF) of degenerated cartilage and meniscus tribosystems during simulated gait conditions [3] and (2) to investigate the impact of HA supplementation on the CoF.

## Material and Methods

6 mild ( $49 \pm 8$  yrs) and 6 severe ( $80 \pm 5$  yrs) degenerated human knee joints were obtained from an official tissue bank (IRB 228/20). 6 mm cylindrical samples were extracted from the cartilage-to-cartilage contact area of the tibial plateau. Three cylindrical plugs were punched out from the anterior horn, posterior horn and pars intermedia of lateral menisci using a 5 mm biopsy punch. Flat cartilage plates (2 x 4 mm) were extracted from of the femur using a microtome blade. The following material pairings were tested: tibial against femoral cartilage (tribosystem cartilage) and femoral cartilage against the femoral-facing side of the meniscus (tribosystem meniscus). Synthetic synovial fluid (sSF) [2] and sSF with HA (Hylan G-F20; sSF + HA) were used as lubricants. Gait-like loading conditions were applied using a dynamic pin-on-plate device [3]. CoF of the simulated stance and swing phase were averaged from the last three cycles after 600 s. Differences in the CoF of mild and severe degenerated samples were analysed using Mann-Whitney testing, while Wilcoxon testing was used to compare the results when using different lubricants.  $p \leq 0.05$  was considered statistically significant.

## Results

Neither, the CoF of the mild against the severely degenerated samples (Figure 1), nor the CoF between the groups using the two different lubricants (sSF against sSF + HA) indicated statistical differences ( $p > 0.05$ ) for any of the tested conditions.

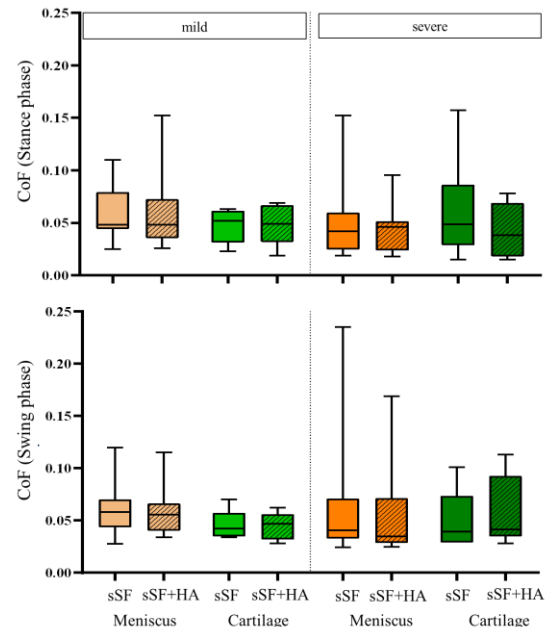


Figure 1: Coefficient of friction (CoF) of the stance phase (top) and swing phase (bottom). Mild and severe degenerated meniscus and cartilage samples were tested with synthetic synovial fluid (sSF) and with sSF and Hyaluronic Acid (sSF + HA). Non-parametric statistical analysis,  $*p < 0.05$ , median with min/max

## Discussion

Our results showed that (1) degenerated cartilage and meniscus still have sufficient functional friction properties under gait-like loading and (2) HA supplementation did not impact the CoF under these conditions. Overall, the CoF of degenerated, human samples were comparable to those of healthy bovine articular cartilage [2]. Although the surface and structure of the tissues changes with degeneration, the interstitial fluid pressurization lubrication seems to maintain its friction reducing effect [3,4]. Moreover, tribological studies have shown that HA is less effective under dynamic conditions [5]. It is known the intraarticular injection of HA reduces pain in-vivo. Based on our results we conclude that the mechanism of therapeutic effect of HA is rather due to biomechanical interactions than tribomechanics. Pin-on-plate friction tests require sample extraction out of the joint's complex anatomy. Thus, future studies are necessary to better understand the role of friction in the progression of OA.

## References

- [1] Altman et al. (2015) BMC Musculoskelet Disord
- [2] Bortel et al. (2015) Lubricants
- [3] Warnecke et al. (2019) Sci Rep
- [4] Caligaris et al. (2004) Osteoarthr. Cartil.
- [5] Bell et al. (2016) IMechE

