FRICTION COEFFICIENT DURING RECIPROCATING SLIDING OF UHMWPE IN RINGER'S SOLUTION

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Statement of the problem

Ultra-high-molecular-weight polyethylene (UHMWPE) has been used as a bearing surface, in total joint prostheses. The understanding of polymer tribology is increasingly important, because efficient tribology of artificial joints has been recognised as a major contributor to their long performance [1—4]. This paper deals with the behaviour of dynamic friction coefficient of UHMWPE in contact with alumina (Al_2O_3), during reciprocating sliding in Ringer's solution, in comparison with dry sliding.

Methods of investigations

Commercially available medical grade UHMWPE for implants (CESTILENE "M-C", DSM Engineering Plastic Products, France) was used as flat static samples. Alumina was used as a ball material (1.5 mm diameter). Sliding tests were realised using a ball-on-flat configuration with linear reciprocating module at CSM Nanotribometer. Five values of normal load, F_n, were used: 100, 250, 500, 750, 1000 mN and three values of maximum linear sliding speed, v: 4; 8; 12 mm/s. Duration of each test was 3000 cycles (total distance of 4.8 m; half amplitude of 0.4 mm). Maximum elastic contact stress, according to applied normal loads, was in a range of 28.5—61.3MPa. Dry sliding and sliding in Ringer's solution were compared. During the test, the dynamic friction coefficients were recorded in a real time.

Results

Real time diagrams of the dynamic friction coefficient (COF) as a function of the sliding cycles were obtained for each test (Fig. 1). In case of dry sliding, friction coefficient reached steady state values shortly after the beginning of the test (Fig. 1, *a*), as well as in case of higher loads and speeds in Ringer's solution. However, in case of the lowest load (100 mN) in Ringer's solution, friction coefficient curve exhibited rather non-uniform behavior (Fig. 1, *b*), even though it reached a steady state value after a certain longer number of cycles. As a rule, low loads and low sliding speeds produced longer running-in periods in case of Ringer's solution. An average value of the dynamic coefficient of friction was calculated, for all test conditions, for a steady state period of friction, as the root mean square function using the raw data. Results showed that the sliding speed exhibited no significant influence on the friction coefficient, while load increase produced its slight decrease.

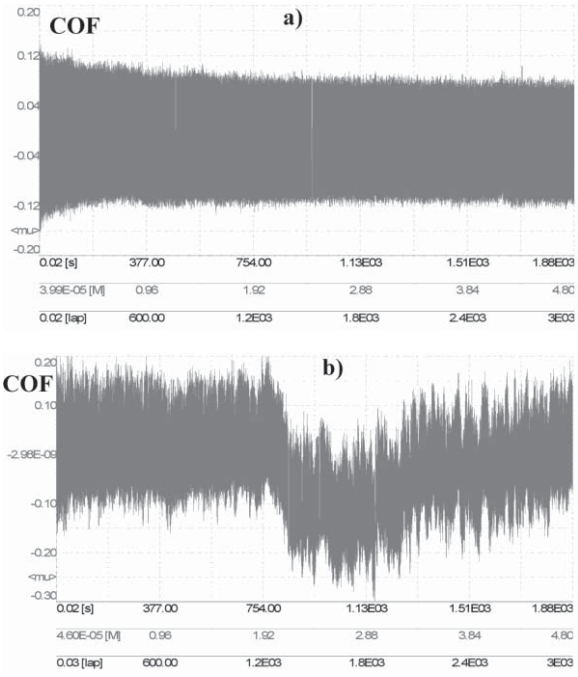

Fig. 1. Dynamic friction coefficient, v = 4 mm/s, F_N = 100mN: *a* — dry sliding, *b* — sliding in Ringer's solution.

Conclusion

For low loads in this study, duration of tests should be significantly prolonged to obtain steady state. There are two distinct zones for wet sliding: (1) significantly higher friction coefficients up to approximately 250 mN, followed by abrupt decrease to (2) rather low values slowly decreasing with further load decrease.

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