【Grant-in-Aid for Specially Promoted Research】
Science and Engineering (Engineering)

Title of Project : Elucidation of adaptive lubrication mechanism with low friction and minimum wear in natural synovial joints and development of artificial hydrogel cartilage with super lubricity based on bionic design

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Research Area : Biomedical engineering, Biomaterials, Biotribology

Keyword : Hydrogel artificial cartilage, Multimode lubrication in synovial joint, Artificial joints based on bionic design, Medical and biological engineering, Tribology

【Purpose and Background of the Research】

With growing elderly population, the number of arthritis patients is increasing. Applications of joint replacements to patients bring the recovery of walking ability and relief of severe pain. However, in certain cases, the revision operations are applied due to the loosening of joint prostheses which is usually derived form wear debris-induced osteolysis. To fully reduce wear in artificial joints, the development of hydrogel artificial cartilage with adaptive multimode lubrication mechanism has been conducted.

【Research Methods】

First, the detailed mechanism of multimode lubrication in natural synovial joints has been elucidated and subsequently those results will be applied to innovative artificial cartilage.

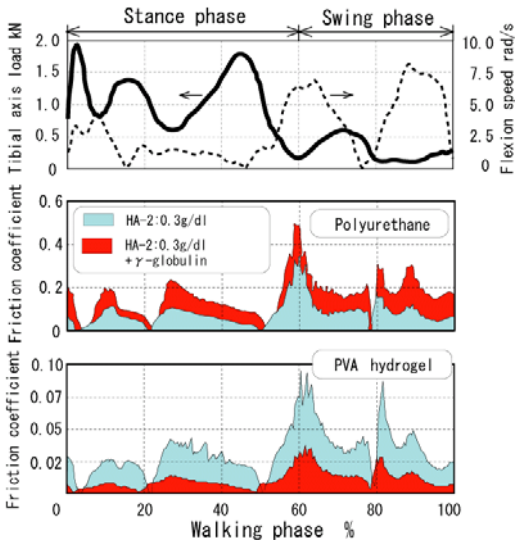

Fig.1 Frictional behavior of artificial cartilage (HA: Hyaluronic acid)

The frictional behaviors of simplified knee prostheses with soft layer during walking in Fig.1 indicated that PVA (poly(vinyl alcohol)) hydrogel with high water content showed very low friction compared with polyurethane layer.

To extend the durability of joint prostheses, the establishment of optimum structure and properties for artificial cartilage as combination of repeated freezing-thawing and cast-dry methods for PVA hydrogel is planned. The collaboration of biomechanics, biotribology, biomaterials and biomedical fields is expected to produce superior artificial cartilage.

【Expected Research Achievements and Scientific Significance】

The establishment of clinical application of artificial cartilage with superior lubricity and longevity is expected. Exquisite devices with advanced hydrogel artificial cartilage will provide a leading guidance on bionic design.

【Publications Relevant to the Project】

(1) T. Murakami, K. Nakashima, Y. Sawae, N. Sakai and N. Hosoda, Roles of adsorbed film and gel layer in hydration lubrication for articular cartilage, Proc. IMechE, Part J, Journal of Engineering Tribology, Vol.223, No.3, 287-295, 2009

(2) K. Nakashima, Y. Sawae, T. Murakami, Influence of protein conformation on frictional properties of poly (vinyl alcohol) hydrogel for artificial cartilage, Tribology Letters, Vol.26, No.2, 145-151, 2007.

(3) E. Otsuka and A. Suzuki, A simple method to obtain a swollen PVA gel crosslinked by hydrogen bonds, Journal of Applied Polymer Science, Vol.114, No.1, 10-16, 2009.

【Term of Project】 FY2011-2015

【Budget Allocation】 348, 900 Thousand Yen

【 Homepage Address and Other Contact Information】

http://biorc.mech.kyushu-u.ac.jp/SPR/index-en.html