The investigation of the interactions between tribological behaviors and biomechanical properties of cartilage

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Abstract

Articular cartilage tissue is located in an active and tribological joint. One of the major functions is to decrease friction and contribute lubrication. As well, the tissue-engineered cartilage is purposed to repair the tribological surface of the damaged cartilage. If a tissue-engineered cartilage cannot withstand the external stress, it will affect cell viability and the balance between extracellular matrix synthesis and degradation. This will lead to the degeneration of cartilage tissue. It is unclear how friction affects mechanical characteristics of cartilage, or how mechanical properties would influence on the changes between extracellular matrix and cell types of a cartilage. Therefore, evaluating biotribological characteristics of a tissue-engineered cartilage becomes critical. Therefore, we established an in vitro cartilage tribology testing system by using porcine knee cartilages. We investigated the effects of surface geometry, reciprocating speeds, and lubricants on tribological properties of cartilage. Our results showed that surface geometry would not affect friction coefficient of cartilage. When cartilage was rubbed in phosphate-buffered saline (PBS) or bovine calf serum (BCS), we found that friction coefficient in BCS was higher than it in PBS. Although it may suggest PBS is a better lubricant, we demonstrated the surface damage was greater when cartilage was rubbed in PBS than in BCS. In addition, our results showed that slower reciprocating speed resulted in a smaller friction coefficient. This will provide a useful database for reference and benefit to develop the functional tissue-engineered cartilage with excellent mechanical strength.

Image

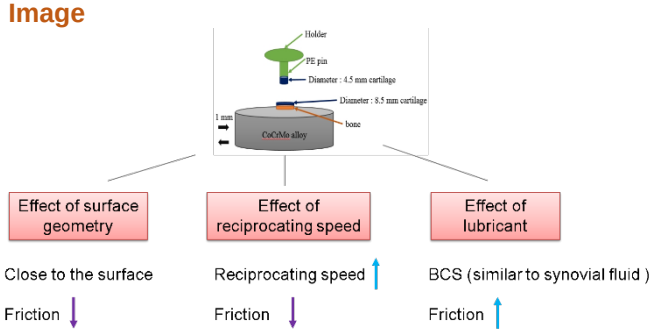


Figure 1. By setting an in vitro cartilage testing system, we can investigate the interactions between tribological behaviors and biomechanical properties of cartilage.

Recent Publications (minimum 5)

1. C.J. Bell, E. Ingham, J. Fisher, "Influence of hyaluronic acid on the time-dependent friction response of articular cartilage under different conditions," *Proc. Inst. Mech. Eng. Part H*, vol. 220, 2006, pp. 23-31.
2. M.P. Heuberger, M.R. Widmer , E. Zobeley, R. Glockshuber, N.D. Spencer, "Protein-mediated boundary lubrication in arthroplasty," *Biomaterials*, vol. 26, 2005, pp. 1165-1173.
3. T. Kitano, G.A. Ateshian, V.C. Mow, Y. Kadoya, Y. Yamano, "Constituents and pH changes in protein rich hyaluronan solution affect the biotribological properties of artificial articular joints," *J. Biomech*, vol. 34, 2001, pp. 1031-1037.
4. E.A. Tsvetkova, "Investigation of friction in a natural cartilage-microporous ultrahigh-molecular-weight polyethylene pair," *Mech. Compos. Mater.*, vol. 39, 2003, pp. 359-364.
5. S. Park, C.T. Hung, G.A. Ateshian, "Mechanical response of bovine articular cartilage under dynamic unconfined compression loading at physiological stress levels," *OsteoArthritis Cartilage*, vol. 12, 2004, pp. 65-73.
6. M. H. Naka, K. Hattori, K. Ikeuchi, "Evaluation of the superficial characteristics of articular cartilage using evanescent caves in the friction test with intermittent sliding and loading," *J. Biomech*, vol. 25, 2005, pp. 1-7.
7. T.P. Andriacchi, A. Mündermann, R.L. Smith, E.J. Alexander, C.O. Dyrby, S. Koo, "A framework for the in vivo pathomechanics of osteoarthritis at the knee," *Annals of Biomedical Engineering*, vol. 32, 2004, pp. 447-457.
8. C.H. Chang, H.W. Fang, H.T. Huang, H.L. Liu, W.M. Lee, M.C. Hsieh, C.S. Chen, "Tribological process induced conformational transformation of protein may change the friction of cartilage" *Materials Letter,* vol. 61, 2007, pp. 3381-3384.



Biography (150 word limit)

Chen-Ying Su's research focuses on understanding biotribological relationship between proteins and biomaterial surface in different systems, such as lysozyme and contact lens, or synovial proteins and artificial joints. She is also interested in developing testing methods that can characterize tissue-engineered products. In addition, she has helped companies during commercialization process by providing her expertise in regulations of medical devices.

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