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Abstract
In this study, the high strength of double-network hydrogel (DN Hydrogel) synthesized from acrylic acid (AAc) and N-isopropyl acrylamide (NIPAAm) to be used as a substitute for nucleus pulposus inside the intevertebral disc was developed. Single-network hydrogels were first synthesized by crosslinking the AAc and the gels were then immersed in NIPAAm solution until they reached equilibrium. The solution was subsequently polymerized with conventional technique and byγ-ray irradiation, respectively, to develop the DN hydrogels. The physical properties of theses hydrogels were characterized, including thermosensitivity, swelling ratio, water content, mechanical properties, and degradation. At 22℃, the swelling ratios of DN hydrogels polymerized with conventional technique (7~23 w/w) and polymerized byγ-ray irradiation(12~28 w/w) both decreased with the increase of the crosslinking agent in the 1st network and also decreased with the increase of the monomer in the 2nd network. The test of thermosensitivity showed the low critical solution temperatures (LCST) of DN hydrogels polymerized by those two methods were about 48~50℃ which is higher than the body temperature, 37℃. At 37℃, the swelling ratios of DN hydrogels polymerized with conventional technique (7~20 w/w) and polymerized byγ-ray irradiation (6~18 w/w) were both smaller than those measured at 22℃, because the measured temperature (37℃) approached the LCST of DN hydrogels and the hydrogels became hydrophobic at this temperature. The water contents were determined from the swelling ratio and they all achieved about 85 % and conformed to the water content of nucleus pulposus. At 37℃, the compressive strengths of SN hydrogels (0.15~0.16 MPa) were smaller than those of DN hydrogels polymerized with conventional technique (0.41~7.46 MPa) and polymerized byγ-ray irradiation(0.47~21.92 MPa). Moreover, the compressive strength of DN hydrogels increased with the increase of the crosslinking agent in the 1st network and also increased with the increase of the monomer in the 2nd network. The swelling ratios of DN hydrogels (6~28 w/w) were smaller than those of SN hydrogels (33~36 w/w) because the structure of DN hydrogels was more compact than those of SN hydrogels. The storage modulus(E', G') and the loss modulus(E", G") of DN hydrogels increased with the increase of the crosslinking agent in the 1st network and also increased with the increase of the monomer in the 2nd network.

The coefficient of surface friction decreased with the increase of the swelling ratios, approximately 2.0×10-3 In the degradation test, the compressive strength of DN hydrogels were decreased after exposing the DN hydrogels to PBS for 6 months. Because the long molecular chains were hydrolyzed to form the short molecular chains. In this study, it did not need any additives to polymerize the hydrogels byγ-ray irradiation, thus lowering the toxicity of the products and making them more compatible to the tissues and organs. Thus, hydrogel prepared byγ-ray irradiation is a promising approach as a substitute for the nucleus pulposus.
Advisory Committee Hong-Ru Lin - advisor

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