Finite Element Analysis of Instrumentation in Cervical Disc Replacement Surgery

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Abstract

Disc replacement technology for the cervical spine surgery is currently undergoing clinical evaluation in the United States. This technology replaces the current method of fusing vertebrae in a patient's spine that permanently limits motion around the fused disc space. The disc replacement technology offers to eliminate the fusion and to replace the degenerated disc with an artificial disc replacement system that restores natural motion to the operated level of the spine. The disc replacement procedure is similar to the traditional anterior discectomy and fusions. For physicians and surgical instrument developers, it is critical to understand how successfully deploy the new artificial disc replacement systems. Otherwise, without proper understanding of the deployment process it is inevitable to injure the vertebral body or to cause the arm pain by compressing the nerve during the surgery. Therefore, cervical disc replacement process includes not to injure the vertebral body endplate during the removal of the disc material and to adequately decompress the nerve in order to ensure elimination of the arm pain. Hence, during the surgical procedure; activities such as compressions and decompressions caused on the vertebrae by new instrumentations that are specially designed for the disc replacement operations need to be cautiously investigated. Moreover, stress and strain concentrations on the life-critical contact locations of the vertebrae must be well comprehended. As a result, in this study, the interactions of a rasp instrument -that is a vastly used instrument in the disc replacement surgery- with cervical bones prior to the artificial disc replacement phase are extensively explored. The purpose of the study is to build finite element models of the cervical vertebrae and the rasp instrument, and analyze interactions between them in order to identify intricacies involved in the surgery. The strain and the stress intensities are computed under the various rasp loadings and impacts that are applied on intervertebral surfaces of the anterior vertebrae to mimic the surgical process.

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