The Investigation of the Effect of PEEK-Rod Fixation Systems on Pedicle Screws and The Adjacent Intervertebral Discs

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Abstract: In recent years, orthopedic fixation devices have been widely used in the treatment of spinal injuries and deformities. In order to decrease the degree of these pathologies in theory, novel spinal motion preservation methods have been developed. In this study, the spine model of an adolescent idiopathic scoliotic patient was developed and the biomechanical effects of a traditional spine implant system and the system of polyetheretherketone (PEEK) were compared. The three-dimensional lumbar spine from L2 to L5 vertebra was developed from computed tomography data. The model involved lumbar vertebrae, intervertebral discs, facet joints, and ligaments. In our study, the L2-L5 lumbar model was subjected to the loads and lateral bending moments. The efficacy of the discs, screws and rods in the models that were composed of two different fixation systems (titanium-rod and PEEK-rod) were evaluated regarding the Von Mises stress and, the maximum shear stress distributions. The finite element analysis was performed and Ansys Workbench was employed in the simulation process. It was determined that the PEEK rod fixation system reduced the equivalent and shear stress values when compared with the titanium-based fixation system. Since adjacent segment disease has become a common drawback of fusion surgeries, intervertebral discs were also examined in each loading condition. According to the results, the PEEK rod system decreased the total deformation and stress values on the adjacent discs (L3-L4 and L4-L5) of the model compared to the other system. Therefore, it was concluded that the fixation devices reduced the loading on the model especially on the discs and ligaments. Besides, compared to traditional rod fixation systems, PEEK rod systems expressed better load-sharing with the reduction of stress at the bone-to-screw interface.

Keywords: finite element analysis; titanium rod; von Mises stress analysis; PEEK rod; adjacent segment disease.