Design of a Lumbar Interspinous Process Fixation Device for Minimizing Soft Tissue Removal and Operation Time

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Abstract : It has been reported that intervertebral fusion surgery, which removes most of the ligaments and muscles of the spine, increases the degenerative disease in adjacent spinal segments. Therefore, it is required to develop a lumbar interspinous process fixation device that minimizes the risks and side effects from the surgery. The objective of the current study is to design an interspinous process fixation device with simple structures in order to minimize soft tissue removal and operation time during intervertebral fusion surgery. For the design concepts of a lumbar fixation device, the principle of the ratchet was first applied on the joining parts of the device in order to shorten the operation time. The coil spring structure was selected for connecting parts between the spinous processes so that a normal range of motion in spinal segments is preserved and degenerative spinal diseases are not developed in the adjacent spinal segments. The stiffness of the spring was determined not to interrupt the motion of a lumbar spine. The designed value of the spring stiffness allows the upper part of the spring to move ~10° which is higher than the range of flexion and extension for normal lumbar spine (6°-8°), when a moment of 10Nm is applied on the upper face of L1. A finite element (FE) model composed of L1 to L5 lumbar spines was generated to verify the mechanical integrity and the dynamic stability of the designed lumbar fixation device and to further optimize the lumbar fixation device. The FE model generated above produced the same pressure value on intervertebral disc and dynamic behavior as the normal intact model reported in the literature. The consistent results from this comparison validates the accuracy in the modeling of the current FE model. Currently, we are trying to generate an abnormal model with defects in one or more components of the normal FE model above. Then, the mechanical integrity and the dynamic stability of the designed lumbar fixation device will be analyzed after being installed in the abnormal model and then the lumbar fixation device will be further optimized.

Keywords : lumbar interspinous process fixation device, finite element method, lumbar spine, kinematics
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