

Finite Element Analysis of the Lumbar Spine after Unilateral and Bilateral Laminotomies and Laminectomy

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Abstract : Laminotomy is a spinal decompression surgery compatible with a minimally invasive approach. However, the unilateral laminotomy for bilateral side decompression leads to more perioperative complications than the bilateral laminotomy. Although the unilateral laminotomy removes the least bone tissue among the spinal decompression surgeries, the difference of spinal stability between unilateral and bilateral laminotomy and laminectomy is rarely investigated. This study aims to compare the biomechanical effects of unilateral and bilateral laminotomy and laminectomy on the lumbar spine by finite element (FE) simulation. A three-dimensional FE model of the lumbar spine (L1-L5) was constructed with the vertebral body, discs, and ligaments, as well as the sacrum was constructed. Three different surgical methods, namely unilateral laminotomy, bilateral laminotomy and laminectomy, at L3-L4 and L4-L5 were considered. Partial pedicle and entire ligamentum flavum were removed to simulate bilateral decompression in laminotomy. The entire lamina and spinal processes from the lower L3 to upper L5 were detached in the laminectomy model. Then, four kinds of loadings, namely flexion, extension, lateral bending and rotation, were applied on the lumbar with various decompression conditions. The results indicated that the bilateral and unilateral laminotomy both increased the range of motion (ROM) compared with intact lumbar, while the laminectomy increased more ROM than both laminotomy did. The difference of ROM between the bilateral and unilateral laminotomy was very minor. Furthermore, bilateral laminotomy demonstrated similar poster element stress with unilateral laminotomy. Unilateral and bilateral laminotomy are equally suggested to bilateral decompression of lumbar spine with minimally invasive technique because limited effect was aroused due to more bone remove in the bilateral laminotomy on the lumbar stability. Furthermore, laminectomy is the last option for lumbar decompression.

Keywords : minimally invasive technique, lumbar decompression, laminotomy, laminectomy, finite element method

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