

Finite element investigation of the effect of Spina bifida on loading of the vertebral isthmus

C Quah, MS Yeoman, A Cizinauskas, K Cooper, D McNally and B Boszczyk

 Author Affiliations

Abstract

Background Spondylolysis (SL) of the lower lumbar spine is frequently associated with spina bifida occulta (SBO). There has not been any study that has demonstrated biomechanical or genetic predispositions to explain the coexistence of these two pathologies.

Purpose To test the hypothesis that fatigue failure limits will be exceeded in the case of a bifid arch, but not in the intact case, when the segment is subjected to complex loading corresponding to normal sporting activities.

Methods Finite element models of natural and SBO (L4-S1) including ligaments were loaded axially to 1kN and were combined with axial rotation of 3°. Bilateral stresses, alternating stresses and shear fatigue failure on intact and SBO L5 isthmus were assessed and compared.

Results Under 1kN axial load, the von Mises stresses observed in SBO and in the intact cases were very similar (differences < 5MPa) having a maximum at the ventral end of the isthmus that decreases monotonically to the dorsal end. However, under 1kN axial load and rotation, the maximum von Mises stresses observed in the ipsilateral L5 isthmus in the SBO case (31MPa) was much higher than the intact case (24.2MPa) indicating a lack of load sharing across the vertebral arch in SBO. When assessing the equivalent alternating shear stress amplitude, this was found to be 22.6 MPa for the SBO case and 13.6 MPa for the intact case. From this it is estimated that shear fatigue failure will occur in less than 70,000 cycles, under repetitive axial load & rotation conditions in the SBO case, while for the intact case, fatigue failure will occur only after more than 10 million cycles.

Conclusion SBO predisposes SL by generating increased stresses across the inferior isthmus of the inferior articular process, specifically in combined axial rotation and anteroposterior shear.

General

Copyright © 2013, British Editorial Society of Bone & Joint Surgery