INTRODUCTION:
Lumbar spondylolysis occurs in approximately 6% of the population. It is well known that patients with spondylolysis show a higher incidence of spondylolisthesis and degenerative disc disease at the involved motion segment. For example, spondylolysis occurs commonly at L5 and spondylolisthesis appears at L5/S. Some authors have also reported that intervertebral disc degeneration may occur at the upper segment adjacent to the lytic level as well and cause symptoms. To understand these clinical observations, we need to investigate biomechanics of both the L4/5 and L5/S segments with the L5 spondylolysis. However, such information are sparse in the literature. In this study, we investigated disc stresses at various levels in the segment using finite element method (FEM).

Buck’s direct repair of the spondylolysis with fixation of the pars defects has been widely used to treat young patients with this disorder. We also investigated the effects of this technique on disc stresses at these two segments.

METHODS:
Finite element model:
An experimentally validated 3-dimensional non-linear finite element model (FEM) of the intact ligamentous L3-S1 segment was used. This model has been previously used to investigate a number of clinically relevant issues (1,2,3,4). Bilateral lumbar spondylolysis was simulated by creating bilateral pars defects with 1.0 (mm) gap at L5 (Figure 1-left). Buck’s direct repair model was also simulated (Figure 1-right) with fusion of the defects with 4.0 (mm) cannulated Titanium screws bilaterally. The yellow dotted line demonstrates the location of the screw on the right side.

Analysis:
Von Mises stresses in the annulus fibrosus (AF) and nucleus pulposus (NP) at L4/5 and L5/S disc levels were analyzed in flexion, extension, lateral bending and axial rotation in response to 400 N of axial compression and 10.6 Nm moment. The highest value in each was compared among the three models; i.e. intact, spondylolysis and Buck’s stabilization.

RESULTS and DISCUSSION:
After spondylolysis, the Von Mises stresses in AF as well as NP increased at all of the locations at both L4/5 and L5/S levels. When compared to L4/5 level (Figure 2), the increase in stresses was larger at L5/S (Figure 3; 15% vs. 90%). These data support the clinical observation that in the spondylolytic spine, the cranial adjacent disc may degenerate, in addition to the involved level disc. This also supports clinical observation that disc degeneration usually occurs more at the affected level rather than the cranial adjacent level.

CONCLUSION:
Spondylolysis increases disc stresses at the affected as well as cranial adjacent level, and it may lead disc degeneration at both levels. However, the increase in stresses is higher at the affected level, when compared to the cranial level. Buck’s screw fixation technique may restore the increased disc stresses at both disc levels. Thus, this technique may be beneficial from a biomechanical perspective.

REFERENCES: