# Short Segment Fixation of An L1 Compression Fracture – 4 vs. 6 Screws

[1]Norton R, [1]Williams S, [2] Milne E, [2] Kaimrajh D, [1]Eismont F, [1,2] Latta L
[1] Orthopedics, Univ. Miami, Miami, FL; [2] MBI, Mount Sinai Med. Ctr., Miami Beach, FL

UHealth University of Miami Health System | University of Miami Miller School of Medicine

Miami CORE — Miami Center for Orthopaedic Research and Education

M.B.I. — Max-Biedermann-Institute for Biomechanics

## PURPOSE:

The standard configuration for posterior short segment fixation involves pedicle screws placed above and below the fracture. However loss of correction and hardware failure have been reported.[1] In 19 patients treated with short segment fixation, bending of the screws occurred in six patients, progressive kyphosis in three patients, and screw breakage in one patient.[2] We hypothesize that placing pedicle screws at the level of the fracture posteriorly can each improve the rigidity of the fixation.

## METHODS:

Thirteen fresh human cadaver spines from T12 to L2 were used for the testing. An L1 compression fracture was created by compression overload of the anterior column. The specimens were instrumented with 6 mm pedicle screws connected to 5.5 mm titanium rods.

Selspot LED emitters were fixed to the T12 and L2 to measure their movements in 6 DOF, from which the relative movements between T12 and L2 could be calculated. Uniaxial strain gages were bonded to the rods to monitor longitudinal strain in the segment of rod between the T12 and L1 screws, and between the L1 and L2 screws. A 200 N follower preload was employed to simulate the stabilizing forces produced by paraspinal musculature. Specimens were cyclically loaded from 5 N·m extension to 5 N·m flexion, well within their elastic range. The two groups were compared statistically by paired Student's t-test.

Two conditions were tested: 1) 4 screw construct: no screws at the L1 fractured body (4S); 2) 6 screw construct: screws at all levels (6S).

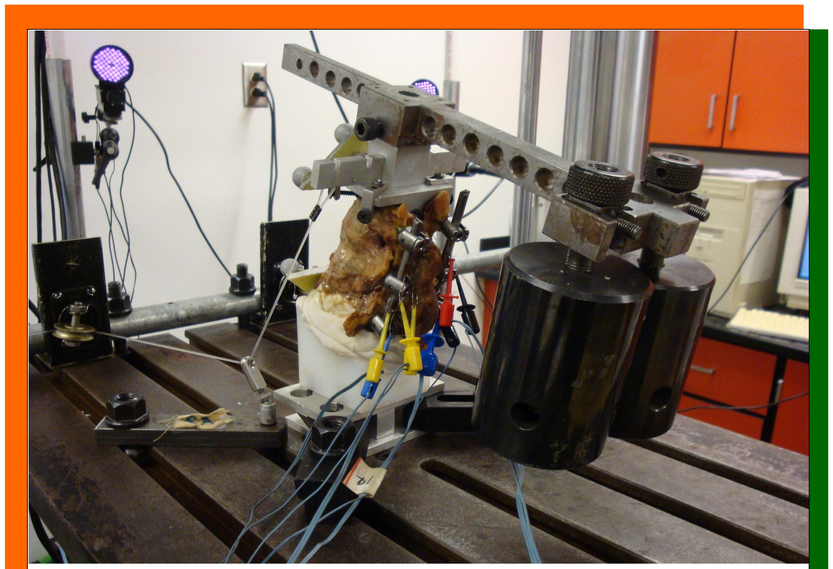

**Figure 1 - T12 to L2 with a compression fracture, fixed with 6 screws and 2 rods with strain gages applied to the open rod segments, ready for load cycles.**

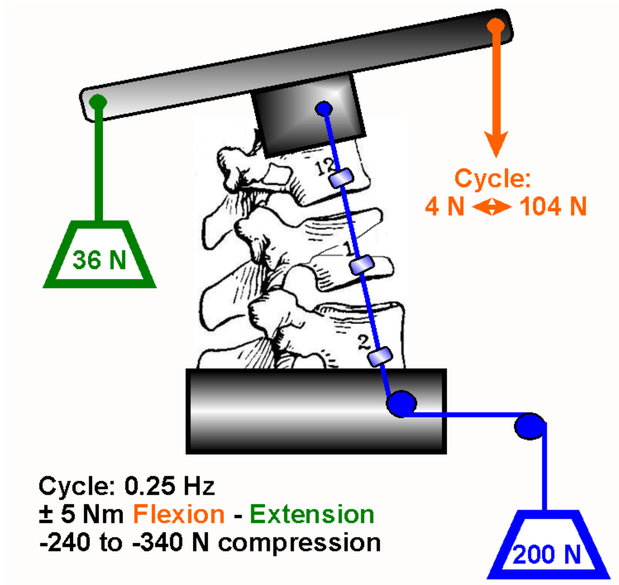


**Figure 2 – Each spine was mounted at the proper anatomic angle. Follower and extension preloads were applied and it was then cycled in flexion – extension loading.**

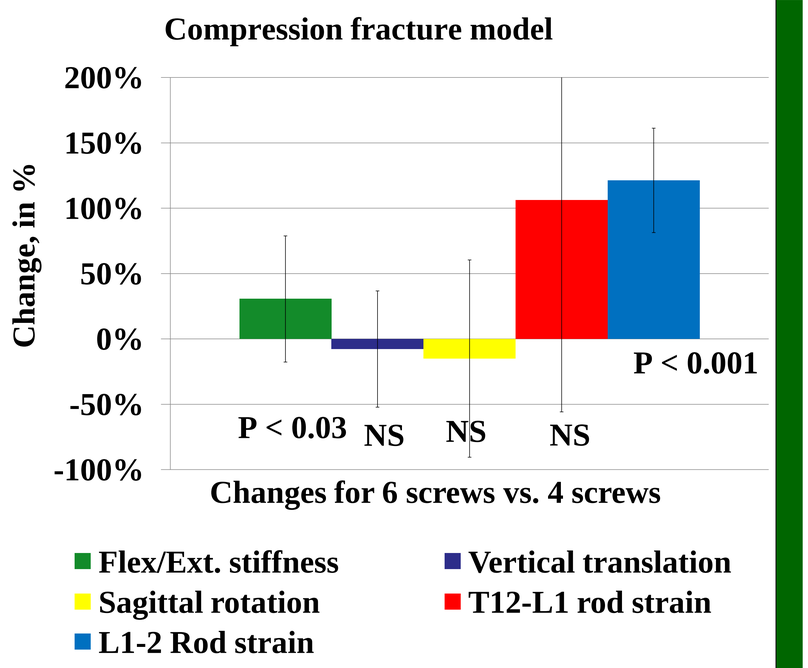


**Figure 3 - The percent change from 4S to 6S for each parameter measured showed significant increases in structural stiffness and rod strains between L1 and T12.**

## RESULTS:

The mean stiffness in flexion and extension was 13.42 N/mm with the 4-screw construct and 17.37 N/mm with the 6-screw construct. This represented a 31% increase in construct rigidity with the addition of the 2 screws in L1 which was statistically greater by paired Student's t-test ($P < 0.03$). Relative movement of T12 compared to L2 was evaluated in terms of axial movement and sagittal rotation between both groups and no significant difference was found between the 4-screw and 6-screw construct. Rod strain changes during motion from flexion to extension were not significantly different between the two groups at T12-L1, however, L1-L2 rod strain was significantly increased in the 6-screw construct compared to 4-screw construct ($p<0.001$) by paired Student's t-test.

## SIGNIFICANCE:

Pedicle screw fixation of L1 compression fractures has improved the biomechanics of treatment of these injuries over the multiple level constructs with hooks and rods. However, fixation at a single level above and below L1 still has reports of mechanical failures. Adding pedicle screw fixation at the level of an L1 compression fracture significantly increased the rigidity of the construct in flexion – extension, which is the most common mechanism of clinical failure. As would be expected, there is more loading on the rods, but with distribution of that load over 50% more screws than the traditional construct. This may reduce the stress on each pedicle screw during cantilever bending thereby lowering the chance of instrumentation failure and collapse into kyphosis.

## DISCUSSION:

In a cadaveric L1 compression fracture, a 6-screw construct with 2 screws in the injured vertebral body is biomechanically superior to a 4-screw construct that skips the injured vertebral body.

mbibiomechanics.org

## REFERENCES:

1. Parker Jet al. Spine 25;1157-1169, 2000.
2. McLain RF et al. J Bone Joint Surg 75A;162-167, 1993.

## ACKNOWLEDGEMENTS:

This project was supported by The Max Biedermann Institute for Biomechanics, Mt. Sinai Medical Center, Miami Beach, FL